GE

Oil & Gas

# RSS-131-ER / RSS-131

# User's Manual

**Part Number: RSS-131-OM**

**Revision: R**
**March 2014**

8499 Darrow Road
Twinsburg, OH 44087

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# Revision History

| Revision | Revision History | Date |
|---|---|---|
| K | Overall update | September 2006 |
| L | Converted to standard format | November 2006 |
| M | Added support for yy/mm/dd format<br>Added detail around backward compatible mode<br>Added description of failure modes<br>Added example of reloading parameters from disk | February 2007 |
| N | Added datasheet for battery disposal | November 2008 |
| P | Added replacement part number notes for the battery and external power supply<br>Removed references to Solar Panel<br>Changed business name from Energy to Oil & Gas<br>Added connector panel graphic<br>Added IP54 rating to Environmental section | January 2014 |
| R | Extended support for PC serial ports COM1-COM9 instead of just COM1-COM4. Added documentation on command line parameter to override last saved COM port value. | March 2014 |

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# ***CAUTION & WARNING STATEMENTS***

**THROUGHOUT THIS MANUAL, WHEN NECESSARY, NOTES ARE USED TO IDENTIFY CONSIDERATIONS:**

**CAUTION**: IDENTIFIES INFORMATION ABOUT PRACTICES OR CIRCUMSTANCES THAT CAN LEAD TO PERSONAL INJURY OR DEATH, PROPERTY DAMAGE, OR ECON0MIC LOSS. CAUTIONS HELP YOU IDENTIFY A HAZARD, AVOID A HAZARD, AND RECOGNIZE THE CONSEQUENCES.

**IF THIS EQUIPMENT IS USED IN A MANNER NOT SPECIFIED BY THE MANUFACTURER, THE PROTECTION PROVIDED BY THE DESIGN OF THIS EQUIPMENT MAY BE IMPAIRED.**

**NO OPERATOR SERVICABLE PARTS. THIS INSTRUMENT SHALL BE SERVICED BY QUALIFIED PERSONNEL ONLY.**

**THIS INSTRUMENT IS MAINTENANCE-FREE, ALTHOUGH THE END-USER'S QUALITY PROGRAM MAY DICTATE A RECALIBRATION INTERVAL.**

**THIS ENCLOSURE MAY CONTAIN ONE SEALED LEAD ACID BATTERY. THIS ENCLOSURE CONTAINS A PRESSURE VESSEL MEETING THE REQUIREMENTS OF 97/23/EC. WHEN SERVICING THE UNIT BY QUALIFIED, APPROVED PERSONNEL, ENSURE THAT POWER IS OFF BEFORE OPENING THE CASE. FAILURE TO DO SO WILL RESULT IN -400V APPLIED TO THE OUTSIDE OF THE CHAMBER AND MAY RESULT IN SHOCK. MISHANDLING MAY BURST THE CHAMBER AND RESULT IN INJURY OR DEATH.**

**THE SENSOR ENCLOSURE MAY ONLY BE OPENED BY CUTTING THE LOCK WIRE USED TO SECURE THE LATCHES. LOCK WIRE MUST BE REINSTALLED AFTER SERVICING AND SEALING THE ENCLOSURE TO ENSURE CONTINUED SAFETY OF THE PRODUCT.**

**THIS INSTRUMENT DOES NOT INCLUDE PROTECTIVE GROUNDING WIRES. IT SHALL BE THE RESPONSIBILITY OF THE USER TO PROVIDE APPROPRIATE GROUNDING OF THIS DEVICE WHEN LOCATED IN AN AREA WHERE THIS MAY BE REQUIRED. CONSULT LOCAL ELECTRICAL CODES AND NORMATIVE REGULATIONS FOR APPROPRIATE GROUNDING REQUIREMENTS.**

**THE (OPTIONAL) INTERNAL BATTERY USED IN THIS INSTRUMENT IS A SEALED LEAD ACID BATTERY AND SHALL ONLY BE REPLACED WITH AN IDENTICAL REPLACEMENT AVAILABLE FROM GE REUTER STOKES. USE OF ANY OTHER BATTERY MAY CAUSE DAMAGE TO THE CHARGING UNIT OR THE INSTRUMENT.**



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GE Oil & Gas

# RSS-131-ER / RSS-131 Gamma Radiation Monitor

# Battery Disposal Instructions

This product may contain Alkaline, Nickel Metal Hydride, Lithium, or Lithium ion batteries. In accordance with the European Directive 2006/66/EC, batteries and accumulators are marked with the crossed out wheeled bin, which indicates that they cannot be disposed of as unsorted municipal waste in the European Union. The marking may also include a chemical symbol (Pb for lead, Hg for mercury and Cd for cadmium) indicating that the battery contains substances classified as hazardous by the European Commission. Users of batteries must use the collection framework available to customers for the return, recycling, and treatment of batteries. Customer participation is important to minimize the negative effects of batteries to the environment and sustain available natural resources. For more information see www.weeerohsinfo.com

Follow the directions outlined for proper removal and disposal of your batteries. The following steps can be performed by any end user of this product.

1. Remove unit from any mounting apparatus.
2. Turn case such that the handle is on top.
3. Remove locking features as required and release latches.
4. Carefully remove top of case without breaking wire or connections.
5. Disconnect wires from circuit board and battery, as necessary, to remove top of case completely.
6. Disconnect any remaining battery connections, and remove battery from unit.
7. Dispose of battery properly according to local laws and regulations.

**UPON REINSTALLATION OF THE BATTERY, ENSURE THE BATTERY LEADS ARE PROPERLY CONNECTED: RED LEAD IS CONNECTED TO (+) AND BLACK LEAD IS CONNECTED TO (-)**

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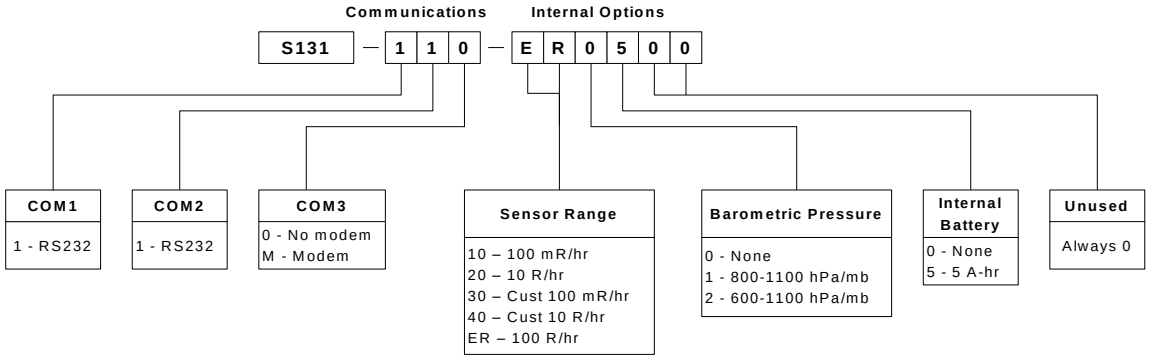
**RSS-131ER Configuration Matrix**




| External Options | | |
|---|---|---|
| **Part Number** | **Description** | **Note** |
| DEV2-87 | Battery Charger, No CE mark | Old style, no cordset, large |
| DEV35-1 | Battery Charger, CE mark | New style, no cordset, small |
| S131-BC-002 | Battery Charger, USA | Old style, no CE, USA cordset |
| S131-BC-003 | Battery Charger, EU/Korea | Old style, no CE, EU/Kor cordset |
| S131-BC-004 | Battery Charger, Hong Kong | Old style, no CE, HK cordset |
| S131-BC-006 | Battery Charger, CE, USA | New style, CE, USA cordset |
| S131-BC-007 | Battery Charger, CE, EU/Korea | New style, CE, EU/Korea cordset |
| S131-BC-009 | Battery Charger, CE,Hong Kong | New style, CE, HK cordset |
| S131-BC-010 | Battery Charger, NJDEP | Old style, no CE, NJDEP only |
| S131-PRGC-001 | Programming Cable | One serves multiple systems |
| S131-232-001 | COM1 RS-232 Cable | Only with ENG approval |
| S131-232-002 | COM2/COM4 RS-232 Cable | One per system |
| S131-SOLR-001 | Solar Power Option 6V | Not with battery |
| S131-AOC-001 | Analog Cable | Backward compatibility w/121 |
| CN7-10 | 4 pin Switchcraft connector | Modem, COM1 customer cable |
| CN7-11 | 6 pin Switchcraft connector | External power customer cable |
| CN7-12 | 7 pin Switchcraft connector | Wind/rain customer cable |
| CN7-13 | 8 pin Switchcraft connector | Analog, COM2/4 cust cable |
| EN3-8 | Tripod | |
| **S131-TB-001** | Tipping Rain Bucket Assy | Includes bucket and cable |
| MET1-6 | Tipping Rain Bucket | |
| S-131-001-26 | Tipping Rain Bucket Cable | 10 feet long |
| **S131-WND-001** | Wind Sensor Kit | Includes wind sensor and cable |
| MET1-9 | Wind Sensor | |
| S131-WDS-001 | Wind Sensor Cable | 10 feet long |
| **S131-KIT-WR** | Wind and rain kit | Includes sensors and cable |
| MET1-9 | Wind Sensor | |
| MET1-6 | Tipping Rain Bucket | |
| S131-TBWS-001 | Rain/Wind cable assembly | 10 feet long |
| **S-131-ESD-001** | Ext Ser RS-232 Disp Kit 20" | Includes display and cable |
| DSP1-1 | Ext Ser Marquee Display 20" | |
| S131-232-003 | Ext Ser Disp Cable DB9 | |
| **S-131-ESD-002** | Ext Ser RS-232 Disp Kit 7.2" | Includes display and cable |
| DSP1-4 | Ext Ser Marquee Display 7.2" | |
| S131-232-004 | Ext Ser Disp Cable Fly Leads | |
| **S-131-ESD-003** | Ext Ser RS-485 Disp Kit 20" | Includes display and cable |
| DSP1-5 | Ext Ser Marquee Display 20" | |
| S131-232-005 | Ext Ser Disp Cable DB9 | |
| DEV27-1 | Black Box 232/485 Converter | |

| Standard Items for Every System | |
|---|---|
| **Part Number** | **Item** |
| **S131-CD*** | **RSS131 Application CD** |
| SFTW-131-001 | RSS131 Firmware |
| SFTW-131-002 | RSS131 Config Utility |
| RSS-131-OM | RSS131 User Manual PDF |
| **S131ER-CD**** | **RSS131ER Application CD** |
| SFTW-131-001ER | RSS131ER Firmware |
| SFTW-131-002 | RSS131 Config Utility |
| RSS-131-OM | RSS131 User Manual PDF |
| **S131-KIT-STD** | **1 per unit** |
| RSS-131-OM | RSS-131 User Manual |
| S131-232-002 | COM2/COM4 RS-232 Cable |
| S131-PRGC-001 | Programming cable |
| CN7-11 | Connector for external power |

* The **S131-CD** contains all software and user manual for the 100 mR/hr and 10 R/hr units.

** The **S131ER-CD** contains all software and user manual for the 100 R/hr ER unit.

| Spare Parts | |
|---|---|
| **Part Number** | **Item** |
| S-131-001-10 | Electrometer (100 mR/hr, 10 R/hr) |
| S-131-001-43 | Extended range electrometer (ER unit) |
| S-131-001-20 | DAQ board without modem |
| S-131-002-20 | DAQ board with modem |

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# Modem Notice

**Type of Service:** The RSS-131 is designed to be used on standard device telephone lines. It connects to the telephone line by means of a standard jack called the USOC RJ-11C (or USOC FJ45S). Connection to telephone company provided coin service (central office implemented systems) is prohibited. Connection to party lines service may be subject to state tariffs.

**Telephone Company Procedures:** The goal of the telephone company is to provide you with the best service it can. In order to do this; it may occasionally be necessary for them to make changes in their equipment, operations or procedures. If these changes might affect your service or the operation of your equipment, the Telephone Company will give you notice, in writing, to allow you to make any changes necessary to maintain uninterrupted service.

In certain circumstances, it may be necessary for the Telephone Company to request information from you concerning the equipment that you have connected to your telephone line. Upon request of the telephone company, provide the FCC registration number and the ringer equivalence number (REN); both of these items are listed on the equipment label. The sum of all of the RENs on your telephone lines should be less than five in order to assure proper service from the Telephone Company. In some cases, a sum of five may not be useable on a given line.

**If problems arise:** If any of your telephone equipment is not operating properly, you should immediately remove it from your telephone line, as it may cause harm to the telephone network. If the Telephone Company notes a problem, they may temporarily discontinue service. When practical, they will notify you in advance of this disconnection. If advance notice is not feasible, you will be notified as soon as possible. When you are notified, you will be given the opportunity to correct the problem and informed of your right to file a complaint with the FCC. Contact your telephone company if you have any questions about your phone line. In the event repairs are ever needed on the RSS-131, they should be performed by GE Reuter Stokes or an authorized representative of GE Reuter Stokes. For information contact GE Reuter Stokes.



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# Introduction
## General

This document applies to the following devices:

- S131-11x-10xxxx (100 mR/hr units)
- S131-11x-20xxxx (10 R/hr units)
- S131-11x-ERxxxx (100 R/hr units)

The RSS-131ER is a self-contained gamma monitor for measuring gamma exposure rates of 0 to 100 R/hr. It replaces the earlier RSS-131 units, which had ranges of only 100 mR/hr or optionally 10 R/hr. Unless otherwise noted, all references in this manual apply to all three versions of the RSS-131.

The system consists of 3 primary sub systems

- Micro-controller
- Electrometer
- High Pressure Ion Chamber (HPIC).

## Firmware

There are two different versions of firmware required to support the various RSS-131 versions. It is crucial the correct firmware be loaded in a unit. These firmware files have different names to indicate which systems they should be used in.

| **Applicable Units** | **Firmware File Name** |
|---|---|
| 100 mR/h (S131-11x-10xxxx) | HPIC.HEX |
| 10 R/hr (S131-11x-20xxxx) | HPIC.HEX |
| 100 R/hr (S131-11x-ERxxxx) | HPIC_ER.HEX |



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## Micro-Controller System

A Maxim DS2251T micro-controller module is used to gather sensor data and perform calculations. The module contains the micro-controller as well as separate RAM chips for data and program storage. Dedicated batteries back up each RAM chip on the module. These batteries maintain program and data for up to 10 years in the absence of power (according to the Maxim data sheet).

Firmware can by updated through COM1 using a custom programming cable and the configuration program supplied with the sensor. This allows new features and program updates to be sent to users for download into program memory without the need to return the product to the factory. In addition to program memory there is data memory capable of storing a total of 20,000 data points along with date and time information for each point collected. This allows the sensors to buffer large amounts of data for transmission to a central computer upon request. Unlike previous generations of sensors, buffer data is not deleted once it is sent to the central computer. This allows multiple devices to request data from the same RSS-131 without concern that another requesting device has erased the memory buffer.

The RSS-131 provides its output via a number of RS-232 ports. Users can request data, configure the system, and update the program's firmware through these ports. All units contain 3 standard serial interfaces (COM1, COM2 and COM4), which can be used for simultaneous access to the communications commands. There is an optional internal modem that uses COM3 if installed. If the internal modem is not installed COM3 is unused.

An optional barometric pressure sensor may be installed inside the unit. External sensors such as tipping rain bucket and wind speed and direction may also be added. External modems may also be connected to COM2 and COM4 if desired.



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## Electrometer

The electrometer provides an analog voltage proportional to exposure rate. The electrometer is directly mounted to the ion chamber to minimize noise. It is connected to the micro-controller by a cable that supplies power to the electrometer and sends the voltage output to an A/D converter on the processor board.

The electrometer consists of three ranges (low, middle and high). It changes between these ranges based on the radiation detected.

## HPIC

The high-pressure ion chamber (HPIC) is a highly sensitive and stable detector for gamma radiation. Gamma ray photons travel through the Argon gas, ionizing the gas and generating current. A high voltage supply biases the detector cathode sweeping the ions out of the gas and generating the current, which is measured by the electrometer and converted to an output voltage.

## Data Buffers

The data acquisition board gathers data from seven internal inputs and supported external sensors. The data for these inputs is stored in circular queues for later retrieval. Once the buffer is full the oldest data point is deleted while the newest data point is added. Individual buffers may be customized to meet individual customer needs..

The sampling interval for each input is configurable with a resolution of one second. Each input is sampled every second, but the queue is updated only at the frequency specified in the configuration parameters. All data is recorded to the queue as an average value calculated over the recording interval. For example, if the board is configured to record a sensor every five minutes it will read the sensor every second for five minutes. Once the five minutes expire the resulting average value will be written to the data queue. If an interval of 0 seconds is entered recording for this sensor will be disabled.

The board supports up to 20,000 total points in the data queues. The number of points for an individual sensor is configurable. Care must be taken not to exceed a total of 20,000 points in the configuration. If more than 20,000 points are specified memory integrity will be corrupted and operation will be unpredictable. This will require the program to be reloaded. If a sensor is not used, the number of data points for that particular sensor may be set to 100 (A small number of points is required even if the sensor is not used). This will provide additional storage for points from other sensors. The default number of points for each queue is listed in Table 1.



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| Sensor | Default recording interval (seconds) | Default points |
|---|---|---|
| Wind speed | 60 | 1000 |
| Wind direction | 60 | 1000 |
| Barometric pressure | 60 | 1000 |
| Radiation | 60 | 10000 |
| Temperature | 60 | 1000 |
| Battery | 60 | 1000 |
| High voltage bias | 60 | 1000 |
| Rain | 3600 | 1000 |

**Table 1: Default Number of Points and Recording Intervals**

The RSS-131 firmware will not allow the number of data points for a specific sensor to be less than 100. If any number of points greater than or equal to 0 and less than 100 are entered the system will default to 100 points. This lower limit for each sensor must be taken into account when determining if the total number of sensor data points is over 20,000. In addition, the Configuration Utility also will not allow more than 20,000 data points to be specified.

The number of data points for a given sensor will actually be somewhat lower than the configured number if the unit loses power or there is a time gap in recorded data for any other reason. When a time gap is detected the timestamp of the first point after the time gap must also be recorded. This consumes additional space in the data queue, which would have been available for data points. For each timestamp recorded the number of available data points will be reduced by one.

If the system is reset and the signature block is not corrupted the number of data points for each sensor and the data in them will remain intact. If, however, the signature block is corrupted or the system rebooted with the specification that the number of data points is to be reconfigured all data will be destroyed and the number of data points for each sensor will be reconfigured. Details on rebooting the board are specified later in this document.

## Configuration File

Each RSS-131 ships from the factory with a configuration file containing parameters unique to that unit. The electrometer constants and radiation conversion factor are the only differences from file to file. These constants must be used in the unit for it to correctly measure radiation and change between ranges.



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# Specifications

## Gamma Measurement

0 to 100R/h (0 to 1000 mSv/hr) (S131-11x-ERxxxx units)
0 to 10 R/h (0 to 100 mSv/hr) (S131-11x-20xxxx units)
0 to 100 mR/h (0 to 1 mSv/h) (S131-11x-10xxxx units)
Accuracy - ±5% at 10µR/h
Temperature drift (-25°C to 55°C)

- Zero < 0.5µR/h
- Gain < 1% of reading
- Angular Dependence < 2% over all angles

## Auxiliary Measurements

Internal - Temperature, High Voltage Bias, Battery Voltage
External - Tipping Bucket Rain Gauge, Barometric Pressure, Wind Speed, Wind Direction
2 x 0-5V Analog Inputs

## Data Storage

20,000 total data points, storage interval 1 to 65535 seconds

## Sample Rate

1 second

## Real Time Clock

< 1 minute per month drift

## Power

6V internal battery (optional) NOTE: replacement batteries can be purchased through GE, part number BT6-1 or Power-Sonic Corporation, part number PS 650-LS.
Operating current 250mA maximum (no internal modem), 350 mA maximum (with internal modem)
External Battery Charger or Solar Power (optional) NOTE: replacement external battery chargers can be purchased through GE. Refer to the available part numbers in the External Options section of the Configuration Matrix on page 176.

## Environmental Range



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-25°C to 50°C, 0%-95% RH non-condensing
IP54 Rated

**Serial Transmission**

3 x RS-232 compatible ports standard
Dial-up Modem (TBR21 compliant) optional

**Mechanical**

Size: 12" x 12" x 14" overall (31cm x 31cm x 36cm)
Weight: 25 lbs. (11kg)
Aluminum Enclosure with integral mounting flange, 2 part catalytic polyurethane paint
Latches and Hardware: Stainless Steel



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## Micro-controller

The data acquisition board uses a Dallas Semiconductor DS2251T micro controller module. This module contains 64K battery-backed SRAM for code and 64K battery-backed SRAM for data. Both are guaranteed to maintain contents for 10 years in the absence of power at 25° C. The board also has a real-time clock that is also battery-backed. The time and date need to be set only once. A block diagram of the board is shown in Figure 1.

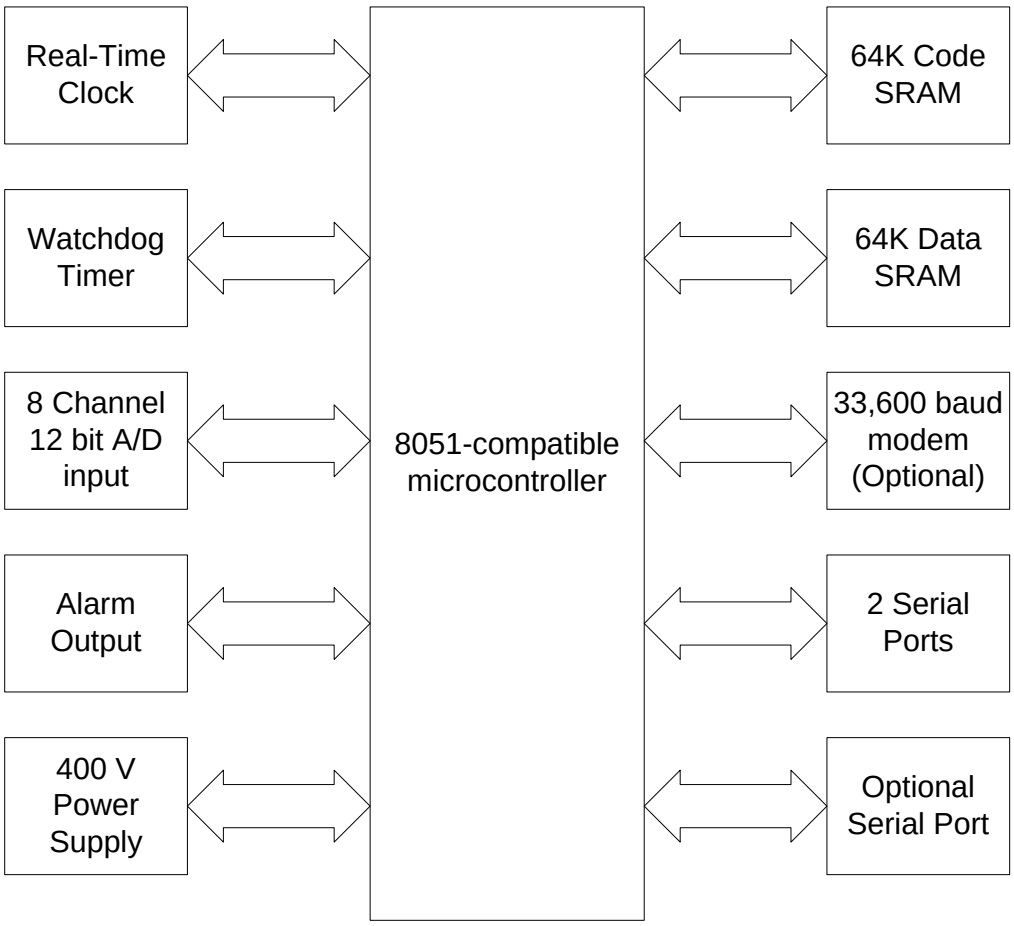


**Figure 1: Micro controller Block Diagram**



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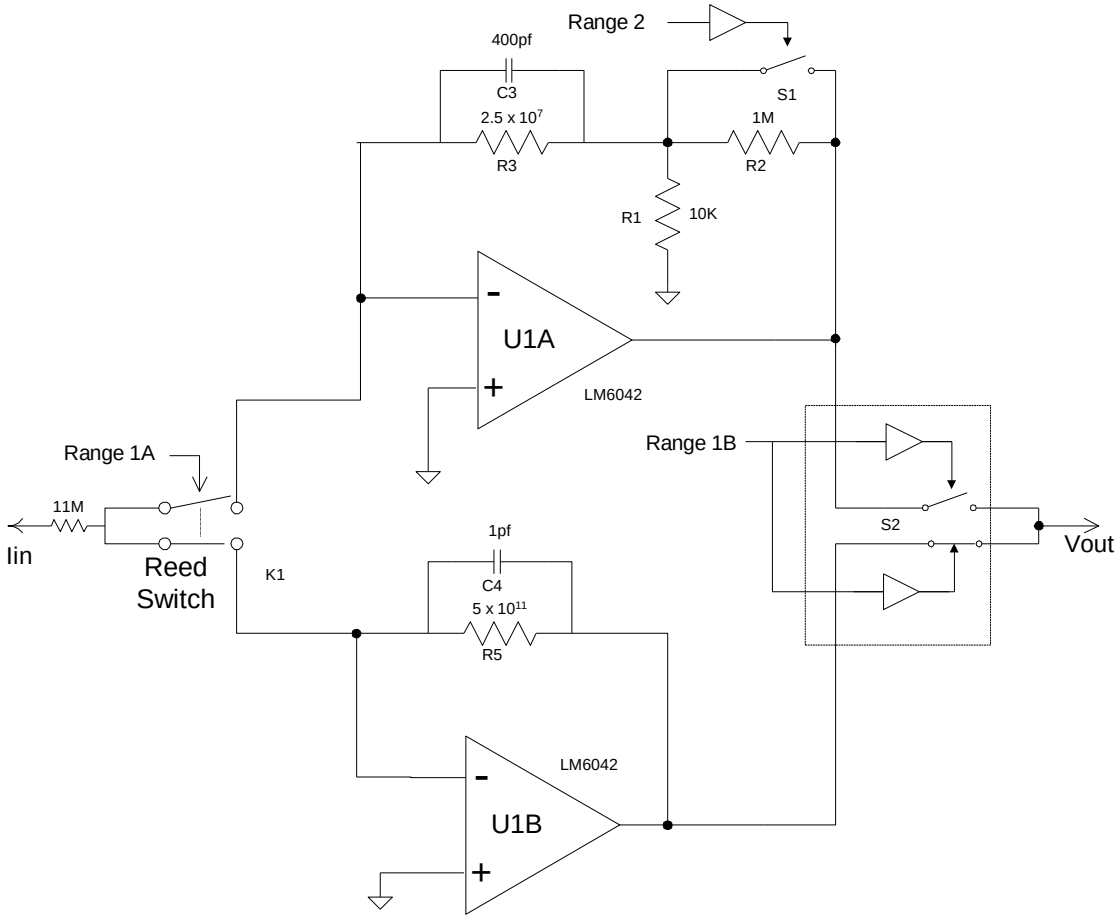
## Electrometer
# Principles of Operation

The electrometer is designed to incorporate standard components and be stable over a wide temperature range. To accommodate the wide dynamic range of the HPIC it has 3 ranges of operation under control of the microprocessor (values shown and equations that follow are for the lower range units, not the extended range units). A block diagram of the electrometer is shown below.



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# Range Selection

In the most sensitive (lowest) range, switch K1 and S2 are connected as shown above. This routes the current from the HPIC to flow through the lower amplifier section generating an output of:

$$Vout = I \times R5$$

$$Vout = I \times 5e11$$

If the dose rate increases such that the output of the electrometer exceeds its full-scale output the microprocessor will switch both K1 and S2 to disconnect the lower amplifier and connect the upper as well as open S1. In this configuration the output of the electrometer is:

$$V_{out} = I \times R3 \times \frac{(R1 \times R2)}{R1}$$

$$V_{out} = I \times 2.5e7 \times 100$$

$$V_{out} = I \times 2.5e9$$

If the output again reaches the full-scale value the unit will change range again to the highest measurement range by closing switch S1 which disables the gain provided by R1 and R2 which means the output is

$$V_{out} = I \times R3$$

$$V_{out} = I \times 2.5e7$$

# Electrometer Zero

Since the characteristics of the electrometer vary with temperature it is important to know these characteristics. One of the most important is the drift of the zero voltage with temperature. The zero is affected by 2 contributing components, input bias current, and input offset voltage. Input offset voltage affects the output directly, so if the offset is 2 mV the output will be offset by 2 mV. Input bias currents are currents that flow into the inputs of the amplifier and relate to the output by the following relationship.

$$V_{out}(offset) = I_{bias} \times R5$$

To measure the zero in-situ, it is necessary to disconnect the HPIC from the amplifier and monitor the output voltage with no signal current flowing. To do this in the low range, S2 remains in the low range connecting the output to amplifier U1B. The input switch K1 however is switched "up" disconnecting the input from U1B. In this configuration the zero can be measured. Conversely to measure the zero in the mid and high ranges switches S2 and K1 are reversed.

# Zero Drift Compensation

To minimize electrometer drift with temperature the electrometer characteristics are measured at the factory and reduced to a series of constants. These constants are entered in the microprocessor's non-volatile memory and used to compensate for temperature drift. Each range is characterized by 4 constants that represent the electrometer as shown in the



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following table. The right column shows the serial command that sets the parameter. The 'x' is replaced by the range designator of 'L', 'M' or 'H' for Low, Mid, and High range respectively. For example to set the nominal zero of the mid range to 1mV the command would be:

#P 0 ZMN .001

For details on the configuration commands see the serial communications section.

| Constant | Description | Serial Command |
|---|---|---|
| Zero | Voltage output at 25°C with no input current from the HPIC | ZxN |
| Zero Drift | Zero voltage drift in volts/°C | ZxD |
| Gain | Nominal feedback resistor value at 25°C | RxN |
| Gain Drift | Resistor drift in ppm/°C | RxV |



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## High Pressure Ion Chamber

# Principles of Operation

The High Pressure Ion Chamber (HPIC) was designed with the objective of achieving the best balance between sensitivity, energy response, stability, measurement range, and accuracy. No one technology has the optimal characteristics for each of these specifications, but the HPIC was selected because it was the best overall solution. The detector consists of a 10-inch stainless steel outer sphere that contains approximately 25 atmospheres of argon. The figure below illustrates the basic detector, with outer 10" cathode and inner 2" anode. In operation a high voltage bias of -400 volts is applied to the outer shell, while keeping the anode at ground potential. When gamma photons pass through the detector they interact with the steel wall as well as the argon gas to generate ionized argon gas molecules. The amount of ionization produced is primarily a function of the number of photons, the gamma ray energy, and the incident direction of the photons. In practice it is assumed that the directional effects average out and that the energy and flux are the most important. The ionization produced will be swept to the anode and cathode by the electric field within the detector, and this generates an electric current that is a function of the incident flux and photon energy.

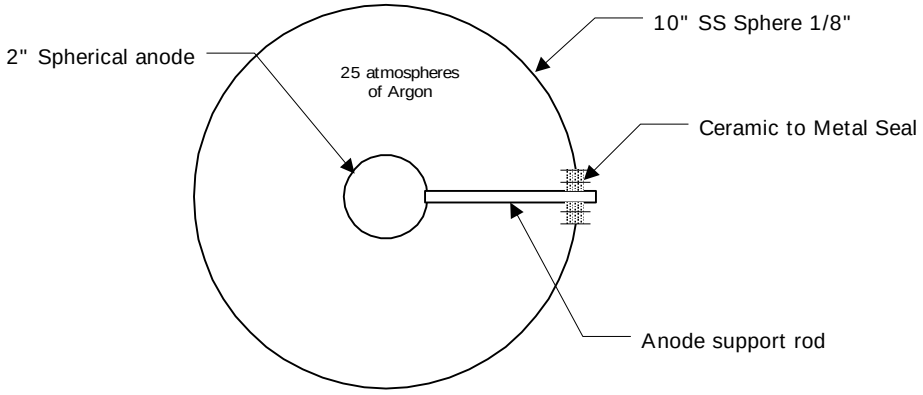


**Figure 2: HPIC Diagram**

The effect of energy on the output is important since the desired relationship is for the energy response is to be "airlike". This means the response of the detector will be proportional to the ionization produced in air. The actual energy response is described in the next section.

The range of the detector is also an important factor. To guarantee a linear output with gamma intensity it is necessary to collect all the ions generated before they recombine and therefore are not measured. To ensure this occurs the bias voltage must be high enough to collect all of the ions. This condition is called saturation. The higher the gamma field the higher the voltage required to achieve saturation. For details on this subject refer to the saturation section below.

There are other characteristics that are important such as accuracy, stability, directional response and others which are not covered in this section. These parameters are functions



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of the entire system including electrometer, analog signal conditioning etc. and therefore are covered in the system specifications.

# Energy Response

Energy response is the signal measured as a function of the gamma ray photon energy. Ideally this response should be flat, such that no energy generates more ions than it would in air. The response is characterized by a curve whose X-axis is energy and the Y-axis the normalized energy response. The normalization of the response means that the nominal response for any energy would be 1.0 if the detector were ideal. For the HPIC the response curve is shown below.

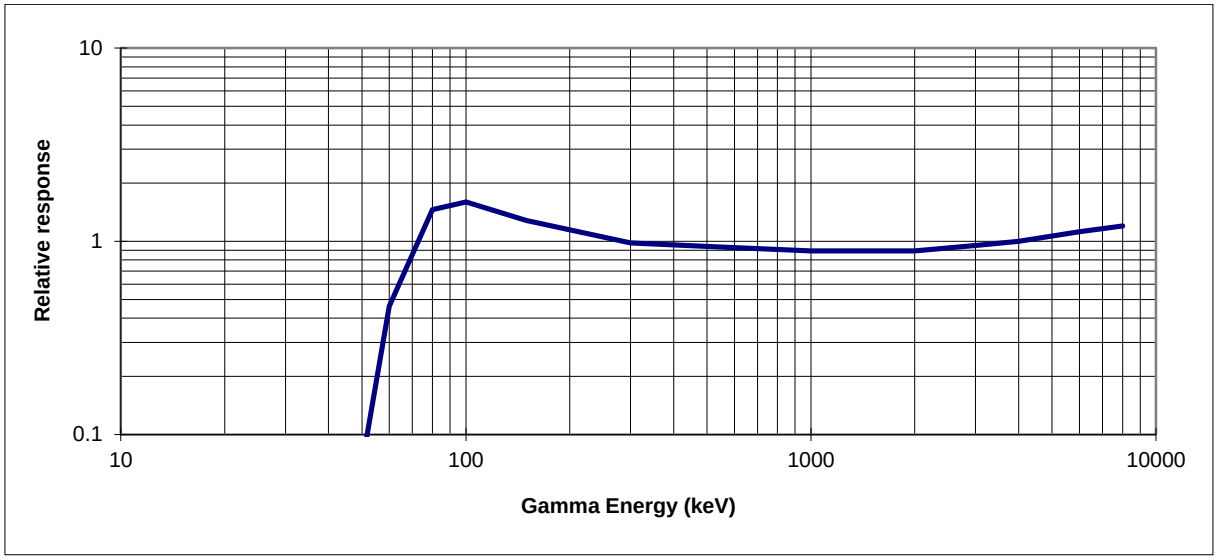


**Figure 3: HPIC Energy Response**

As can be seen the response is not flat across the measurable energy range and the ability to measure gamma's falls off below 60KeV. The result of this is that some isotopes will over respond and some will under respond as compared with the air equivalent standard. Overall this difference is not great and in most applications it is not considered. One reason for this is that to apply a correction requires one to know the energy of the incident photons. If this is known a correction factor can be applied. This factor, referred to as the "F' factor, is the correction to be applied to compensate for the non ideal nature of the response. Since each isotope has a different response the calibration of the detector must be referenced to a known isotope, and for this sensor the reference is $Ra^{226}$.



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## Determining the "F" factors

The first task is to calculate the normalized response for the isotopes. If the isotope emits only one energy this would be a matter of finding the response value on the Y-axis for the energy of the photons. For most isotopes however it is not so simple since they have more than one energy line. Each energy and the percentage of that energy to the total must be considered. The factors for the most common elements are shown in the following table.

| Isotope | Energy (MeV) | F |
|---|---|---|
| Co-60 | 1.17, 1.21 | 0.89 |
| Cs-137 | 0.667 | 0.91 |
| Ra-226 | Various | 0.91 |
| Kr-85 | 0.5 | 0.94 |
| Kr-85m | 0.15, 0.3 | 1.19 |
| Kr-87 | 0.4, 0.85, 2.6 | 0.93 |
| Kr-88 | 0.19, 2.4, 0.85, 2.2,1.55 | 0.92 |
| Xe-133 | 0.081 | 1.46 |
| Xe-133m | 0.233 | 1.11 |
| Xe-135 | 0.25, 0.6 | 1.07 |
| Am-241 | 0.059 | 0.46 |

**Figure 4: F factors for common isotopes**

These values can be used to provide a correction factor if the source of the gamma field is known. Since the detector is calibrated with respect to $Ra^{226}$ this correction is the ratio of the measured isotope to the $Ra^{226}$ "F" factor. A table of these correction factors is shown below.

| | |
|---|---|
| Co-60 | 0.980 |
| Cs-137 | 1.002 |
| Ra-226 | 1.000 |
| Kr-85 | 1.035 |
| Kr-85m | 1.314 |
| Kr-87 | 1.027 |
| Kr-88 | 1.013 |
| Xe-133 | 1.608 |
| Xe-133m | 1.223 |
| Xe-135 | 1.178 |
| Am-241 | 0.507 |

**Figure 5: Correction Factors**

To use these factors assume you were measuring $Co^{60}$ and a dose rate of 150uR/h was measured. To correct this reading this value should be multiplied by 0.98, yielding 147uR/h.



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# Saturation Characteristics

The issue with the saturation of the detector is to insure that all of the ions generated are measured. If the bias voltage is not high enough some of these ion recombine which effectively means the output is no longer linear with exposure rate. The voltage required to collect all of the ions generated is termed the saturation voltage, which varies with the dose rate being measured. A typical saturation curve for dose rate levels of 1.0 and 10.0 mR/h is shown below.

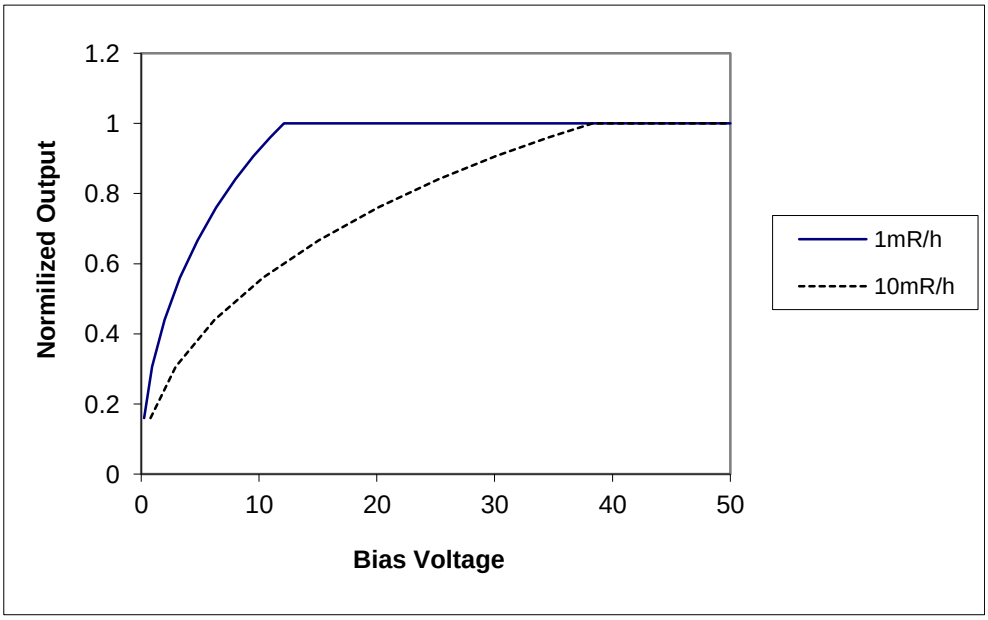


**Figure 6: Saturation Curves**

To insure collection of all the ions a voltage of about 13 volts is required if the field is 1mR/h and a bias of 49 volts at 10mR/h. For the standard range of 100mR/h the saturation voltage is approximately 125 volts, which is well under the 400 volt bias voltage applied to the detector.

## Range Extension

As an option on the RSS-131 the range can be extended to 10R/h. To accomplish this a correction must be applied to the output since the saturation voltage for this level exceeds the 400V bias voltage. This can be done because the saturation curve for the detector is the same from unit to unit and is verified by testing each sensor. By knowing how the detector responds it is then possible to apply a correction to the output at levels above the level where the detector is linear with dose rate.



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## Radiological

# Accuracy and Calibration

Accuracy is often misunderstood and can be confused with the statistical characteristics of the measurement. Accuracy is a measurement of how well the detector reports a reading relative to the actual radiation present assuming the sampling time is long enough such that statistical errors are not significant. Another component of accuracy is drift, primarily caused by temperature variations in the environment or long term drifting over time. Each of these issues is described in the following section.

# Calibration Accuracy

The calibration technique is very important since it determines the underlying accuracy of the measurement. The accuracy of the calibration is affected by 3 major components, the radiation source accuracy, and radiation field stability during calibration and measurement error. The radiation source used is nominal 12 mCi of $Cs_{137}$ that is certified by NIST to an accuracy of ±3%. This certification establishes the best accuracy achievable. The field variations during calibration are minimized by performing measurements with and without a lead shield in the path of the primary beam of radiation. By subtracting these two measurements the background and the scattered components of the source are eliminated. A more detailed explanation of this calibration method is provided in the appendix. Last is the measurement error as a result of statistical and experimental error. Two techniques are used to minimize these errors: long averaging times, and repeated calibrations at multiple distances. Averaging times are selected to reduce the statistical errors to a negligible amount in comparison to the 3% source accuracy. Performing multiple calibrations at a number of distances insures reproducibility since regardless of the distance the calibration factor of the detector should be the same.

For a complete description of the "shadow shield" method refer to the appendix.

# Temperature Drift

Temperature drift is minimized in two ways in the design of the RSS-131. First is by incorporating a differential FET front end in the electrometer. This differential FET is used to measure the current generated by the ion chamber. In previous designs a single FET was used, which required the FET to operate at an experimentally determined operating point to minimize drift. By using a matched pair of FET's the majority of the temperature dependency is removed. However some characteristics of the electrometer are still sensitive to temperature although to a much lesser extent. Primarily these dependencies are in the leakage current and offset voltage of the input. To minimize these effects the microprocessor firmware compensates for drift by using a series of constants that represent the characteristics of the electrometer. These constants are determined by a test procedure performed on each electrometer that calculates these constants. These values are entered into the RSS-131 non-volatile memory.

# Statistical Response

The statistics of the measurement is one area that can be overlooked but is very important to the determination of changes in dose rate. Basically any radiation measurement has



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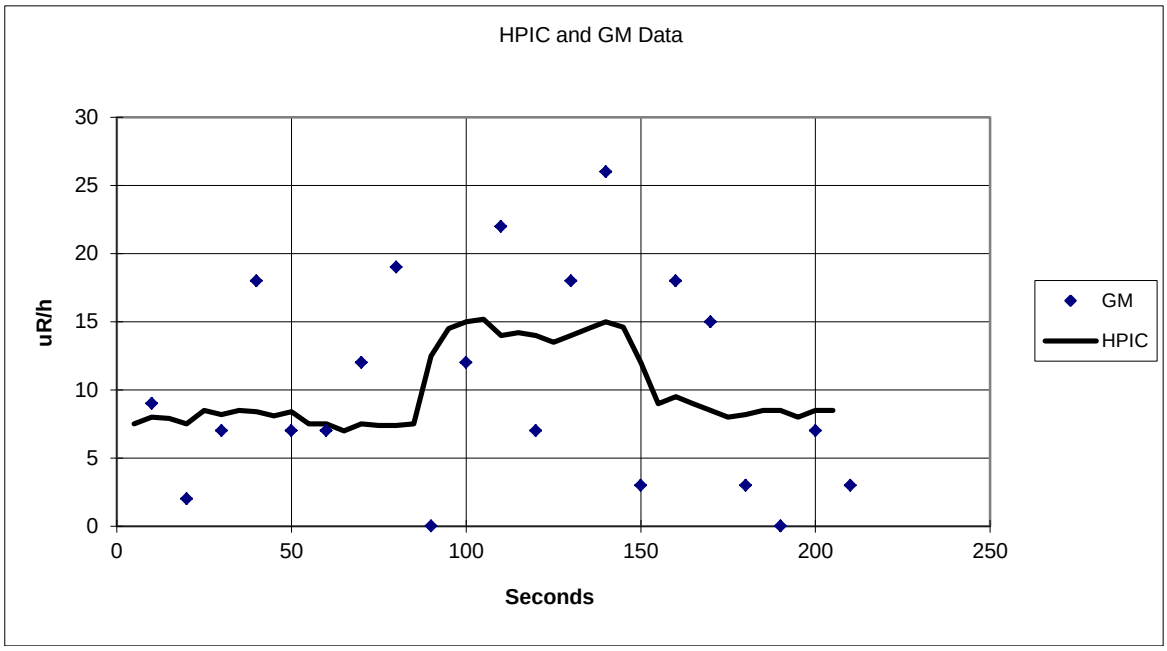
statistical variation associated with the measurement due to the random nature of the gamma photons being measured. The more noise in the measurement the longer one must average the signal for a given confidence level. To illustrate the point the following graph shows data taken from the HPIC and a cylindrical GM counter. The "calibration" of each of these detectors may be the same but the amount of time required to achieve a given statistical accuracy is quite different. In this example the field increased from 8 uR/h to 15 uR/h, but with the GM output it is much less clear what actually happened during this period.



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# Directional Response

One of the strengths of the HPIC is the uniform angular response to incident photons. This is due to the spherical design of the detector as compared with cylindrical detectors that do not have $4\pi$ symmetry. The directional characteristics are primarily due to the detector but are also affected by the packaging and internal components of the sensor. As a result, the response graph below does show a 2% reduction in signal in the direction of the mounting flange on the bottom of the sensor. Even this small amount is usually not a factor since this flange is normally pointed to the ground. For comparison a typical cylindrical GM sensor is also shown on the graph. As can be seen the difference between the 0° and 90° is as much as 20% that can lead to significant errors depending on the direction of the photons relative to the detector orientation.

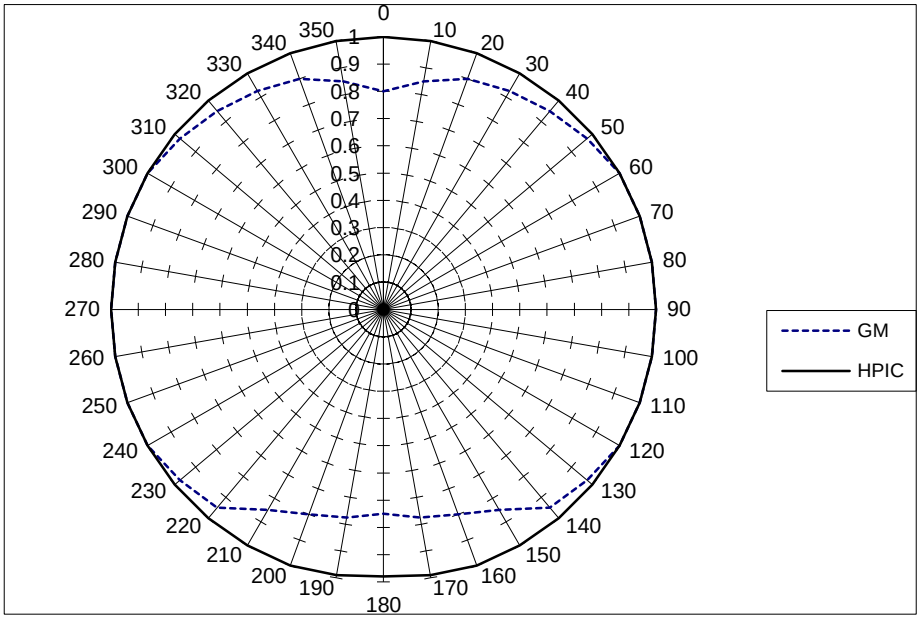


**Figure 7: Directional Response**



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# Alarms

The RSS-131 generates alarms when any of the sensors record a value that is above or below configurable thresholds for that sensor. These threshold values are set using the serial "#P" command described later in this document. When an alarm is generated, the DIGITAL_OUT1 pin goes high (it is low when there are no active alarms). This signal is available for attachment to user-supplied equipment that can take some action when an alarm occurs. So long as at least one alarm is active this signal will remain high. When no alarms are active this signal will return to its normal off (low) state.

The limits which determine alarm levels are set using the RSS-131 Configuration Utility (detailed later in this document). To disable alarms for a given sensor either the upper or lower limit for that sensor should be set to 0. This will disable both upper and lower limit alarms.

The values for upper and lower limits should be entered in absolute units, not the units displayed when reading data queues from the RSS-131. For example, if the RSS-131 is displaying radiation in mR/hr a radiation value of 100 uR/hr would be displayed as .100 (.1 mR/hr). However, to specify this as a limit it would be entered as 1e-4 since 100 uR/hr is really .0001 R/hr.

If a conversion factor has been specified so radiation is reported in something other than mR/hr (conversion factors are specified using the "#P * HEU nn" command) the alarm levels specified should also take this conversion factor into account.

**Table 2** summarizes conditions necessary for an alarm to be generated on the RSS-131.

| Condition | Per Alarm ? | Comment |
|---|---|---|
| Low alarm limit | Yes | This is the low value at which an alarm is generated. If 0, all alarms for the specified sensor will be disabled. See **Table 5** for specific parameters corresponding to individual sensors. |
| High alarm limit | Yes | This is the high value at which an alarm is generated. If 0, all alarms for the specified sensor will be disabled. See **Table 5** for specific parameters corresponding to individual sensors. |
| Alarm dial out phone number set | No | This is the phone number which will be dialed in the event any configured alarm is generated. If this is blank, no message will be sent to any outside systems. |

**Table 2: RSS-131 Alarm Requirements**



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When an alarm condition is detected the RSS-131 checks to see if a phone number has been specified. If the phone number is blank no alarm will be generated. If the phone number has been specified the RSS-131 will attempt to dial the phone number specified. Assuming a computer with modem is attached to the phone number specified the RSS-131 will send a message indicating which unit generated the alarm and the alarm value. A typical message would look as follows:

**Unit 0 Alarm: Radn value = .0512**

If the RSS-131 is unable to deliver the alarm message the RSS-131 will attempt to redial three times. After three redial failures (a total of four attempts) the RSS-131 will quit attempting to deliver the alarm. Whether the alarm message is delivered to a remote PC or not no further alarms will be generated for this sensor until the alarmed condition is removed and appears again.



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# Serial Communications

## Serial Interface

The unit supports up to four serial ports identified as COM1 through COM4. COM1, COM2 and COM4 are standard on all systems. COM3 is dedicated to an optional internal modem.

COM1, COM2 and COM4 all act as standard RS-232 serial ports. COM1 supports only 8 data bits, one stop bit and no parity at 1200, 2400, 4800, 9600, and 19200 baud.

COM2 and COM4 support all standard baud rates up to 115,000. However, the micro-controller cannot keep up with sustained throughput at rates above 9600 baud. COM2 and COM4 allow the number of data bits and parity to be changed dynamically through the Configuration Utility. RTS/CTS handshake is also available on these ports. Changes are effective immediately without requiring a reset.

COM3 consists of an optional 33,600 baud modem. This port is dedicated solely to modem functionality and cannot be used for any other function. It will automatically adjust to the baud rate and parity of the received data.

Simultaneous transmission is supported on all serial ports. However, due to the nature of the multitasking operating system the lower numbered ports (such as COM1) have priority over the higher numbered ports (such as COM4). If only short messages are being transmitted from the RSS-131 there will be no noticeable difference in response. However, if larger blocks of data (such as the entire contents of a data queue) are being sent on multiple serial ports the higher numbered ports will pause while the lower numbered ports take priority.



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# Serial Command Summary

The serial protocol allows users to read and write configuration parameters, read data from the circular queues and troubleshoot the machine. Fields within the commands are separated by spaces for readability purposes. Commands are case insensitive so they may be entered as either upper or lower case. The device address ranges from 0 to 99 (0 is the default) and may be entered as either one or two digits if the ID is less than 10.

All commonly used serial commands are listed in **Table 3**. Additional diagnostic and configuration commands are listed in the Appendix. All serial messages start with '**#**'. Data bytes that are italicized in the sections following the table represent variables that should be substituted with user parameters. All data is eight bit ASCII so it may be easily entered from a standard terminal program such as HyperTerminal. Each command must be terminated by a carriage return <CR>. If a user makes a mistake it can be deleted using the backspace key (ASCII 0x08). The unit ID that is common in the serial protocol provides the ability to put the units in a multidrop system that uses RS-485. If not being used in such a system the ID may be specified as '*' which will cause any unit that receives the command to respond.

The unit ID specified in serial commands must be the same as the ID of the unit or a '*', which will cause any unit that receives the command to respond. Care must be taken when using the '*' as the ID in a multi unit system, however, since all units in the system will respond and may result in contention on the communication link.

If a command is entered incorrectly the unit will not echo an error message. This is to prevent contention on the communication link in a multi unit system.

| Command | Function |
|---|---|
| A | RSS-1013 compatible command |
| C | Clear one or all data queues |
| D | RSS-1013 compatible command |
| L | RSS-1013 compatible command |
| M | RSS-1013 compatible command |
| P | Parameter display / modify |
| Q | Display queue data from start time to end time |
| S | Display sensor data one time |
| T | Set time and date |
| U | Get uptime |
| V | Get version information |

**Table 3: Common Serial Commands**



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# Custom Checksum/CRC

The #Q and #D serial data commands support an optional custom checksum/CRC which is stronger than the standard ASCII checksum calculation. For backward compatibility this option should not be used as the older Reuter Stokes systems do not support this.

The checksum/CRC is calculated by adding up the ASCII values of all the characters in the given string (which is from the beginning of the response up through the last character before the checksum/CRC field). The low-order byte of the longword result of this addition is converted into a two-character string (the checksum value) by:

'OR'ing the low order nibble with 60 hex and placing the result in the second character position, then 'OR'ing the high order nibble with 60 hex and placing the result in the first character position.

The CRC is calculated by 'XOR'ng the ASCII values of all the characters in the given string. The low-order byte of the longword result is converted into a two-character string (the CRC value) by:

'OR'ing the low order nibble with 60 hex and placing the result in the second character position, then 'OR'ing the high order nibble with 60 hex and placing the result in the first character position.



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## Configuration Commands

Configuration commands are used to change settings in the RSS-131.

# Command Syntax

All configuration requests use the "P" command followed by the address and parameter designator. To view a parameter setting the last parameter is omitted. The format of the command is.

***#P yy ppp dddd***<CR>

***yy*** = the HPIC ID. This is a one byte value that ranges from '0' to 'Z' (ASCII) excluding '@'.

***ppp*** = configuration parameter specified as outlined in the following table

***dddd*** = A variable length field specifying the value to set the parameter. This is not present when reading the current value of the configuration

RESPONSE

A read command will display the 3 digit identifier and current value of the parameter requested as shown below.

**<CR>**

**HPI 60**

EXAMPLES:

**#P 0 HPI**<CR> to read the HPIC output interval in seconds when the unit address is 1

**#P 0 HPI 60**<CR> to set the HPIC output interval to 60 seconds

# Commands

Changing certain parameters requires the board be restarted manually by the user before they take effect. All parameters that may be set or viewed are listed here for reference. For details associated with changing parameters see the serial protocol section. Parameters with an asterisk (*) after their 3 digit ID require the system be restarted prior to the change taking effect. Normal configuration parameters are listed in **Table 5**. Lesser used simulation commands are listed in an appendix at the end of the manual. The general naming convention used to specify a parameter for one of the sensors is listed here as an aid in remembering sensor parameter names.

All floating point numbers are stored in IEEE-754 format and may be between +/- 1.175494E-38 to +/- 3.402823E+38.



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| | |
|---|---|
| S = wind speed | PT = # points |
| P = pressure | PI = point interval |
| D = wind direction | |
| H = radiation | AL = alarm low value |
| V = 400V | AH = alarm high value |
| B = battery | |
| T = temperature | |
| R = rain | |
| Z = HPIC Zero | |
| C1=Com port 1 | B = Baud rate |
| C2=Com port 2 | P = Parity |
| C3=Com port 3 | |
| C4=Com port 4 | |

**Table 4: Parameter Naming Convention**



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| Variable | Three Digit ID | Description | Range | Default |
|---|---|---|---|---|
| **Wind Speed** | | | | |
| Wind speed points | SPT* | Number of wind speed points in queue | 0-5000 | 1000 |
| Wind speed interval | SPI | Seconds between wind speed points. If this parameter is set to 0 no data will be gathered for this sensor. **Changing this parameter will delete all points in the queue before changing the point interval !** | 0-65535 | 60 |
| Wind speed alarm level low | SAL | Any sensor value that is lower than this value will trigger an alarm condition. A value of 0.0 will disable this feature. | | 0.0 |
| Wind speed alarm level high | SAH | Any sensor value that is higher than this value will trigger an alarm condition. A value of 0.0 will disable this feature. | | 0.0 |
| Wind speed constant | SPC | This value multiplied by the number of cycles/second is the value recorded in the data queue and returned to the user. Its default value is for the Young Wind Monitor | | .2192 |
| **Pressure** | | | | |
| Pressure points | PPT* | Number of pressure points in queue | 0-5000 | 1000 |
| Pressure interval | PPI | Seconds between barometric pressure points. If this parameter is set to 0 no data will be gathered for this sensor. **Changing this parameter will delete all points in the queue before changing the point interval !** | 0-65535 | 60 |
| Pressure alarm level low | PAL | Any sensor value that is lower than this value will trigger an alarm condition. A value of 0.0 will disable this feature. | | 0.0 |
| Pressure alarm level high | PAH | Any sensor value that is higher than this value will trigger an alarm condition. A value of 0.0 will disable this feature. | | 40.0 |
| **Wind Direction** | | | | |
| Wind direction points | DPT* | Number of wind direction points in queue | 0-5000 | 1000 |
| Wind direction interval | DPI | Seconds between wind direction points. If this parameter is set to 0 no data will be gathered for this sensor. **Changing this parameter will delete all points in the** | 0-65535 | 60 |



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| Variable | Three Digit ID | Description | Range | Default |
|---|---|---|---|---|
| | | **queue before changing the point interval !** | | |
| Wind direction alarm level low | DAL | Any sensor value that is lower than this value will trigger an alarm condition. A value of 0.0 will disable this feature. | | 0.0 |
| Wind direction alarm level high | DAH | Any sensor value that is higher than this value will trigger an alarm condition. A value of 0.0 will disable this feature. | | 0.0 |
| **Radiation** | | | | |
| Radiation points | HPT* | Number of radiation points in queue | 0-5000 | 10000 |
| Radiation interval | HPI | Seconds between radiation points. If this parameter is set to 0 no data will be gathered for this sensor. **Changing this parameter will delete all points in the queue before changing the point interval !** | 0-65535 | 60 |
| Radiation alarm level low | HAL | Any sensor value that is lower than this value will trigger an alarm condition. A value of 0.0 will disable this feature. | | 0.0 |
| Radiation alarm level high | HAH | Any sensor value that is higher than this value will trigger an alarm condition. A value of 0.0 will disable this feature. | | 50e-6 |
| Radiation filter coefficient | RAI | This value determines how much smoothing is applied to radiation readings. A larger value results in more data smoothing, while a lower value results in less data smoothing. | 0-3 | 3 |
| Radiation constant | RAC | This value is determined when the unit is calibrated. The value is obtained from external calibration equipment at 25 degrees C. During normal operation this value is multiplied by the current detected to determine the amount of radiation detected. **This value is unique to each RSS-131 and is determined during calibration. It can be found on the calibration certificate provided by the factory.** | | 2.5E-8 |
| **Bias Voltage** | | | | |
| Bias voltage points | VPT* | Number of bias voltage points in queue | 0-5000 | 1000 |



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| Variable | Three Digit ID | Description | Range | Default |
|---|---|---|---|---|
| Bias voltage interval | VPI | Seconds between Bias voltage points. If this parameter is set to 0 no data will be gathered for this sensor. **Changing this parameter will delete all points in the queue before changing the point interval !** | 0-65535 | 60 |
| Bias voltage alarm level low | VAL | Any sensor value that is lower than this value will trigger an alarm condition. A value of 0.0 will disable this feature. | | 250.0 |
| Bias voltage alarm level high | VAH | Any sensor value that is higher than this value will trigger an alarm condition. A value of 0.0 will disable this feature. | | 500.0 |
| **Battery** | | | | |
| Battery points | BPT* | Number of battery points in queue | 0-5000 | 1000 |
| Battery interval | BPI | Seconds between battery points. If this parameter is set to 0 no data will be gathered for this sensor. **Changing this parameter will delete all points in the queue before changing the point interval !** | 0-65535 | 60 |
| Battery alarm level low | BAL | Any sensor value that is lower than this value will trigger an alarm condition. A value of 0.0 will disable this feature. | | 5.5 |
| Battery alarm level high | BAH | Any sensor value that is higher than this value will trigger an alarm condition. A value of 0.0 will disable this feature. | | 8.5 |
| **Temperature** | | | | |
| Temperature points | TPT* | Number of temperature points in queue | 0-5000 | 1000 |
| Temperature interval | TPI | Seconds between temperature points. If this parameter is set to 0 no data will be gathered for this sensor. **Changing this parameter will delete all points in the queue before changing the point interval !** | 0-65535 | 60 |
| Temperature alarm level low | TAL | Any sensor value that is lower than this value will trigger an alarm condition. A value of 0.0 will disable this feature. | | 0.0 |
| Temperature alarm level high | TAH | Any sensor value that is higher than this value will trigger an alarm condition. A value of 0.0 will disable this feature. | | 100.0 |



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| Variable | Three Digit ID | Description | Range | Default |
|---|---|---|---|---|
| **Rain** | | | | |
| Rain tip volume | RTV | Volume of rain for each gauge tip | | 10 |
| Rain tip points | RPT* | Number of temperature points in queue | 0-5000 | 1000 |
| Rain tip interval | RPI | Seconds between temperature points. If this parameter is set to 0 no data will be gathered for this sensor. **Changing this parameter will delete all points in the queue before changing the point interval !** | 0-65535 | 3600 |
| Rain tip alarm level low | RAL | Any sensor value that is lower than this value will trigger an alarm condition. A value of 0.0 will disable this feature. | | 0.0 |
| Rain tip alarm level high | RAH | Any sensor value that is higher than this value will trigger an alarm condition. A value of 0.0 will disable this feature. | | 0.0 |
| **Input Configuration** | | | | |
| A/D Channel 0 multiplier | AD0 | This value is the inverse of the voltage divider network on the input to channel 0 of the A/D converter. This is not used for channel 0. | | 1.0 |
| A/D Channel 1 multiplier | AD1 | This value is the inverse of the voltage divider network on the input to channel 1 of the A/D converter. This is not used for channel 1. | | 2.0 |
| A/D Channel 2 multiplier | AD2 | This value is the inverse of the voltage divider network on the input to channel 2 of the A/D converter. | | 3.0 |
| A/D Channel 3 multiplier | AD3 | This value is the inverse of the voltage divider network on the input to channel 3 of the A/D converter. | | 101.0 |
| A/D Channel 4 multiplier | AD4 | This value is the inverse of the voltage divider network on the input to channel 4 of the A/D converter. | | 2.5 |
| A/D Channel 5 multiplier | AD5 | This value is the inverse of the voltage divider network on the input to channel 5 of the A/D converter multiplied by the gain of the op-amp (100). | | 102.0 |
| A/D Channel 6 multiplier | AD6 | This value is the inverse of the voltage divider network on the input to channel 6 of the A/D converter. | | 2.0 |
| A/D Channel 7 | AD7 | This value is the inverse of the voltage | | 1.0 |



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| Variable | Three Digit ID | Description | Range | Default |
|---|---|---|---|---|
| multiplier | | divider network on the input to channel 7 of the A/D converter. | | |
| **Electrometer Zero** | | **These values are unique to each RSS-131 and are determined during calibration. They can be found on the calibration certificate provided by the factory.** | | |
| Electrometer low range zero | ZLN | Electrometer voltage measured in low range zero state at 25°C. | | 0 |
| Electrometer middle range zero | ZMN | Electrometer voltage measured in middle range zero state at 25°C. | | 0 |
| Electrometer high range zero | ZHN | Electrometer voltage measured in high range zero at 25°C. | | 0 |
| Electrometer low range zero variation | ZLD | Variation in electrometer voltage measured in low range zero state. Value entered in V/°C. | | 0 |
| Electrometer middle range zero variation | ZMD | Variation in electrometer voltage measured in middle range zero state. Value entered in V/°C. | | 0 |
| Electrometer high range zero variation | ZHD | Variation in electrometer voltage measured in high range zero state. Value entered inV/°C. | | 0 |
| **Electrometer Gain** | | **These values are unique to each RSS-131 and are determined during calibration. They can be found on the calibration certificate provided by the factory.** | | |
| Electrometer low range resistance | RLN | Total nominal electrometer resistance in low range at 25°C. | | 5e11 |
| Electrometer middle range resistance | RMN | Total nominal electrometer resistance in middle range at 25°C. | | 2.2e9 (2.5e9)[1] |
| Electrometer high range resistance | RHN | Total nominal electrometer resistance in high range at 25°C. | | 1e7 (2.5e7)[1] |
| Electrometer low range resistance variation | RLV | Variation in electrometer resistor over temperature. Value entered in PPM/°C. | | 0 |
| Electrometer middle range resistance variation | RMV | Variation in electrometer resistor over temperature. Value entered in PPM/°C. | | 0 |
| Electrometer high range resistance | RHV | Variation in electrometer resistor over temperature. Value entered in PPM/°C. | | 0 |

[1] The value outside parenthesis is for the RSS-131ER device, while the value inside parenthesis is for the older 100 mR/hr and 10R/hr devices.



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| Variable | Three Digit ID | Description | Range | Default |
|---|---|---|---|---|
| variation | | | | |
| **General** | | | | |
| Unit ID | UID | Unit ID | '0'-'Z', except '@' | 0 |
| Radiation conversion factor | HEU | Constant that is multiplied by recorded data value (in mR/h) to obtain value that is returned to the user. This should be 1.0 for mR/h, other values can be entered by the user for conversion to Gy/h or Sv/h. | | 1.0 |
| Date Format | DTF | 0 = mm/dd/yy 1 = dd/mm/yy | 0 or 1 | 0 |
| Watchdog Timer Enable | WDE | 0 to disable watchdog timer, 1 to enable watchdog timer (**default)**. The watchdog timer has a fixed duration of 100 ms. If the watchdog timer is enabled and it is not reset within this time frame, the micro-controller will reset itself. All data will remain intact within the queues. If this is changed, the device must be rebooted using the #Y serial command (#Y 0 2) before it takes effect. | 0 or 1 | 1 |
| **COM1** | | | | |
| COM1 baud rate | C1B | Baud rate for COM1 (1200, 2400, 4800, 9600, 19200). Effective immediately. | | 9600 |
| **COM2** | | | | |
| COM2 baud rate | C2B | Baud rate for COM2 (300, 600, 1200, 2400, 4800, 9600, 19200) ). **Effective immediately.** | | 9600 |
| COM2 Parity | C2P | Parity for COM2 (E,O,N) ). **Effective immediately.** Setting parity to E or O automatically sets data bits to 7. Setting parity to N automatically sets data bits to 8. | E,O,N | N |
| COM2 Handshaking | C2H | RTS/CTS Handshaking). **Effective immediately**.<br>0 = No handshaking,<br>1 = RTS/CTS<br>> 1 Specifies delay after RTS before transmitting (mSec). | 0,1, or > 1 | 0 |
| **COM3** | | | | |
| COM3 baud rate | C3B | Baud rate for COM3 (1200, 2400, 4800, 9600, 19200) ). **Effective immediately.** | | 9600 |



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| Variable | Three Digit ID | Description | Range | Default |
|---|---|---|---|---|
| COM3 Parity | C3P | Parity for COM3 (E,O,N) ). **Effective immediately**. Setting parity to E or O automatically sets data bits to 7. Setting parity to N automatically sets data bits to 8. | E,O,N | N |
| COM3 Modem Init. String | C3I | Initialization string sent to modem on startup. May be up to 40 characters long. | | "" |
| **COM4** | | | | |
| COM4 baud rate | C4B | Baud rate for COM4 (300, 600, 1200, 2400, 4800, 9600, 19200) ). **Effective immediately.** | | 9600 |
| COM4 Parity | C4P | Parity for COM4 (E,O,N) ). **Effective immediately.** Setting parity to E or O automatically sets data bits to 7. Setting parity to N automatically sets data bits to 8. | E,O,N | N |
| COM4 Handshaking | C4H | RTS/CTS Handshaking**). Effective immediately**.<br>0 = No handshaking,<br>1 = RTS/CTS<br>> 1 Specifies delay after RTS before transmitting (mSec). | 0,1, or > 1 | 0 |
| | | | | |
| **Alarm Dial** | | | | |
| Alarm Phone Number | ADN | Phone number used to dial a remote site in case of an alarm. If this field has a length of 0 characters no remote site will be called in the event of an alarm. This field may contain up to 14 characters. The phone number can be reset by entering a value of 'N' in versions 1.61 and later. Previous versions required all parameters be reset to clear this value. | | "" |
| **External Serial Display** | | | | |
| RSS-131 Serial Port | XDP | This parameter specifies which serial port on the RSS-131 is connected to the external serial display. Valid values are:<br>0 – No external display<br>1 – COM1<br>2 – COM2<br>4 – COM4 | 0-4 | 0 |



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| Variable | Three Digit ID | Description | Range | Default |
|---|---|---|---|---|
| | | Note that COM3 is not supported because the internal modem is dedicated to COM3. | | |
| Display units | XDU | This parameter specifies whether radiation will be displayed in R/hr or Sv/hr. The display will automatically scale the output so it will be in mR/hr, uR/hr, etc. Valid values are:<br>0 – R/hr<br>1 – Sv/hr | 0-1 | 0 |

**Table 5: Configurable Parameters**



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# Data Commands

These commands are used to access RSS-131 data.

## Clear Data Queue (#C)

This command will clear one or all data queues.

COMMAND

**#C *yy x***<CR>

***yy*** = the HPIC ID. A one byte value that ranges from '0' to 'Z' (ASCII) excluding '@'.

***x*** = one digit ID specifying which queue is to be cleared

| | |
|---|---|
| '0' = Wind speed | '6' = Battery |
| '1' = Auxiliary Input | '7' = Temperature |
| '2' = Barometric Pressure | '8' = Rain |
| '3' = Wind direction | '9' = Zero |
| '4' = HPIC Output | |
| '5' = 400V | 'a' = Clear all queues |

RESPONSE

The HPIC will return "**Queue cleared**".

EXAMPLES:

**#C 1 7**<CR> to clear all data from temperature queue

**#C 1 a**<CR> to clear all data from all queues



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# Display Queue Data (#Q)

This command will display all queue data for the specified device between the specified start and end dates. If the start date is specified with no start time and no end date/time, all data points from midnight of the start date until the current time will be retrieved. If start date and time are both specified, but no '-' and no end date/time, all data points from the specified start time until the current time will be retrieved. If neither start nor end times are specified all data points in the queue will be displayed.

If an end date (***eeee*** below) is specified both the start date and start time must be specified. If an end date is specified, however, the end time may be omitted. In this case the end time will be midnight of the specified end date.

Values entered are not required to be exactly two digits. For example, February 7, 1998 could be entered as any of the following strings: 02/07/98, 2/7/98, 02/7/98, 2/07/98, 02/07/1998, 2/7/1998, 02/7/1998 or 2/07/1998.

The data will be returned in the units listed below. The only one that may be returned in different units is radiation (#4). The default unit is mR/hr, but other units may be returned by changing the radiation unit parameter using the "#P * HEU *n*" command where *n* is the new unit conversion factor. For mR/hr a value of 1.0 (the default) should be used. For custom values other units may be specified. For example, .00879 could be specified for Gy/hr.

If data is being downloaded and the user needs to terminate the download before transmission is complete, the download may be aborted by send three carriage returns. This will cause the transmission to stop and "^C" will be echoed to the user.

COMMAND

***#Q yy n ssss tttt – eeee uuuu***<CR>

***yy*** = the HPIC ID. A one byte value that ranges from '0' to 'Z' (ASCII) excluding '@'.

***n*** = the ID of which queue is to be read.

'0' = Wind speed (*)

'1' = Auxiliary Input

'2 = Barometric Pressure (psia)

'3' = Wind direction (°)

'4' = HPIC Output (mR/h by default, but other units possible)

'5' = Bias Voltage (V)

'6' = Battery voltage (V)

'7' = Temperature (°C)

'8' = Rain gauge (*)

'9' = Electrometer zero

(*) Units depend on conversion factor for the sensor

***ssss*** = Start date for which queue data is to be returned. This must be entered in the form mm/dd/yy.

**tttt** = Start time within start date for which queue data is to be returned. This must be entered in the form hh:mm:ss.

**'-'** = Literal separator between start and end times



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***eeee*** = End time at which queue data is no longer to be returned. This must be entered in the form mm/dd/yy.

**uuuu** = End time within end date for which queue data is to be returned. This must be entered in the form hh:mm:ss.

RESPONSE

All data from the specified queue in the time interval specified will be returned. The first line will show the recording interval. The second line will show the date and tie of the first data point. Subsequent lines will display up to 10 data points. So long as the duration between points matches the recording interval displayed on the first line no additional time stamps will be displayed. However, if a different duration is detected the time stamp of the next data point will be displayed before data is again sent.

If only a start date and time are specified all data from the start time until the present will be displayed. If neither date nor time are specified all data in the specified queue will be displayed. The end of data is indicated by an extra carriage return - line feed pair.

EXAMPLES:

**#Q 1 4 01/01/80 05:30:00 - 12/01/80 13:00:00**<CR> to return radiation data between 5:30:00 AM 1/1/80 and 13:00:00 12/1/80

**#Q 1 6 04/22/93 00:00:00** <CR> to return all battery voltage data since midnight 4/22/93

**#Q 1 4** <CR> to display all radiation data from the start of the buffer regardless when that may be.

**#Q 0 4 04/22/95 05/04/95**<CR> This is ***invalid*** since no '-' separates the dates and no start time was specified.

**#Q 0 4 04/22/95 - 05/04/95**<CR> This is ***invalid*** since no start time was specified.

**#Q 0 4 04/22/95 13:00:00 - 05/04/95**<CR> This is ***valid*** even though no end time was specified.

SAMPLE OUTPUT:

*nnn* Sample interval in seconds

mm/dd/yy hh:mm:ss (Displayed as dd/mm/yy if DTF configuration option =1)

<data>

<data> is displayed ten values per line so long as there is no time gap in recorded data followed by a five digit sum of the numeric values contained in the data values. Each data value will be represented by five bytes with the decimal point shifted according to the data value.

As soon as a time gap is detected the display moves to the next line and displays the timestamp of the first point recorded after the time gap. Data then is displayed as detailed above.

A sample output with a time gap is shown below. In this example the board is configured to record data every 8 seconds. Data was recorded beginning at 14:22:33 and continued for



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just under 4 minutes before the unit was manually powered down and then restarted shortly thereafter. Radiation has been configured to report mRoentgens per hour (HEU = 0).

**<CR>**

**00:00:08 ;8 seconds between points**

**05/29/98 14:22:33 ;start time**

**.0079 .0068 .0078 .0079 .0077 .0084 .0074 .0083 .0076 .0070 00129 ;data starting at 14:22:33**

**.0075 .0077 .0074 .0079 .0078 .0072 .0076 .0080 .0073 .0073 00118**

**.0073 .0079 .0074 .0070 .0073 .0071 .0084 .0083 00085**

**05/29/98 14:28:50 ;time of first point after gap**

**.0066 .0078 .0077 .0087 .0082 .0073 .0078 .0067 .0076 .0068 00131 ;data starting at 14:28:50**

**.0069 .0074 .0080 .0070 .0079 .0079 .0077 .0076 .0075 .0069 00127**

**.0080 .0075 .0079 .0078 .0082 .0070 .0081 .0079 .0071 .0074 00112**

**.0076 .0080 .0075 00033**



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# Display Sensor Data (#S)

This command will display the current calculated value once per second for all sensors followed by a <CR>. The data sent will be the instantaneous value for each sensor after going through the appropriate conversions. These are the values that are summed together and divided by the recording interval to obtain the value that is written to the queue. Data will continue to be displayed until any character is received at the COM port. The order of sensors in the line is:

- Wind Speed (*)
- Auxiliary Input (V)
- Barometric Pressure (psia)
- Wind Direction (°)
- HPIC (mR/h)
- High Voltage (V)
- Battery Voltage (V)
- Temperature (°C)
- Rain gauge (*)

(*) Units depend on conversion factor for the sensor

COMMAND

**#S *yy***<CR>

***yy*** = the HPIC ID. A one byte value that ranges from '0' to 'Z' (ASCII) excluding '@'.

RESPONSE

**<CR>**

**.0000 .0000 .0000 .0000 .0085 547.8 5.688 22.40 .0000**

**.0000 .0000 .0000 .0000 .0082 547.3 5.684 22.40 .0000**

**.0000 .0000 .0000 .0000 .0086 547.3 5.682 22.40 .0000**



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# Set Time and Date (#T)

This command allows the user to set or view the time and date. If all parameters are specified the time and date are set to the values on the command line. If only the first two parameters are specified the user will see the current time and date values displayed.

**NOTE:**

The RSS-131 supports both mm/dd/yy and dd/mm/yy date formats. Make sure the correct format is set in the RSS-131 using the "#P * DTF" serial command before setting time and date if there is any doubt of which format is currently specified.

COMMAND

**#T *yy dddd tttt***<CR>

***yy*** = the HPIC ID. A one byte value that ranges from '0' to 'Z' (ASCII) excluding '@'.

***dddd*** = Date which is to be set. This must be entered in the form mm/dd/yy.

***tttt*** = Time which is to be set. This must be entered in the form hh:mm:ss. It must be in 24-hour format (from 0 to 23).

RESPONSE

The HPIC will echo the time back to the user.

**<CR>**

**03/25/97 02:24:35**

EXAMPLES:

#**T 0 12/12/96 18:30:0**<CR> to set the date to 12/12/96 and the time to 6:30:00 PM

#**T 0 03/25/97 2:24:35**<CR> to set the date to 3/25/97 and the time to 2:24:35 AM

**#T 0**<CR> to display the current time



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# Get Uptime (#U)

This command returns the number of minutes the device has been monitoring since the last reset.

COMMAND

**#U *yy***<CR>

***yy*** = the HPIC ID. A one byte value that ranges from '0' to 'Z' (ASCII) excluding '@'.

RESPONSE

The uptime information will be returned. A typical display looks as follows:

**<CR>**

**Uptime: 3 Days 6 Hrs 4 Mins**

EXAMPLES:

**#U 0**<CR> to return the length of time the system has been operational.

# Get Version Information (#V)

This command will return RSS-131 firmware version information.

COMMAND

**#V *yy***<CR>

***yy*** = the HPIC ID. A one byte value that ranges from '0' to 'Z' (ASCII) excluding '@'.

RESPONSE

The version information will be returned. A typical display looks as follows:

**<CR>**

**SFTW-131-001ER Ver 5.0**

EXAMPLES:

**#V 0**<CR> to return the version information



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## Compatibility with Older RSS-1013/RSS-121 Units

The RSS-131 supports a significant subset of the serial commands used on the older RSS-1013 and RSS-121 units (hereafter referred to as the older units). This section describes differences in operation between the modes as well as the older commands which are supported.

**NOTE:** This mode of operation is not recommended for systems made entirely of RSS-131s. It should be used only on existing systems which include both RSS-131 and older units where existing central collection software is already in place using older commands.

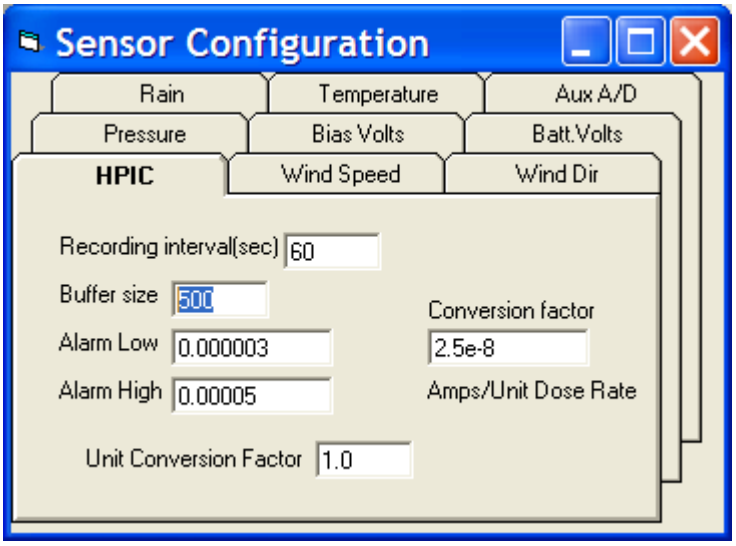
## Data Buffers

The older units supported fixed buffer sizes of 300 or 500 points based on the firmware version. The RSS-131 can emulate these older units with a fixed buffer size using the supported backward compatible commands, but specific steps must be taken. These are listed below:

- Configure the radiation buffer for 300 or 500 points
- Reset the unit with the option that preserves the number of data points specified (note that all data in the buffers will be deleted). If this is not done, the unit will transmit data differently from the old units.
-

## Detailed steps to configure RSS-131 data buffers to act like older units

First, configure the unit for 300 or 500 data points, depending on how the unit is to operate.



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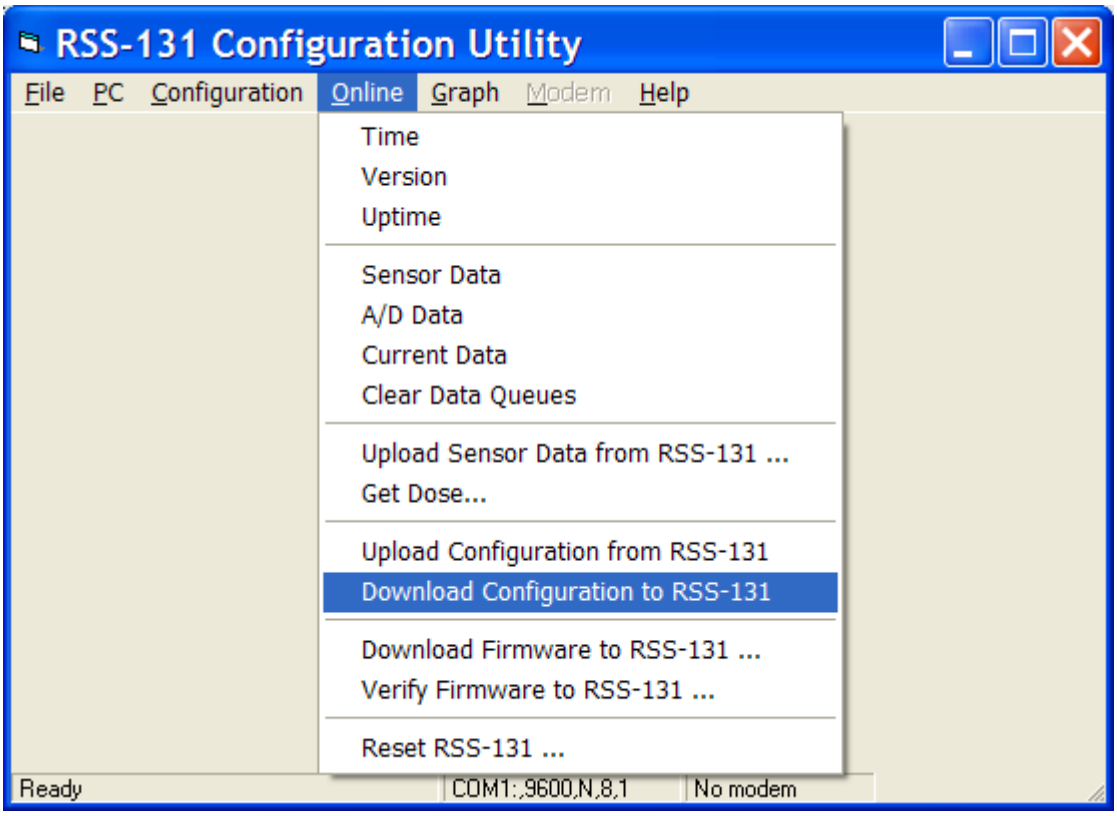
Next, be sure to transfer the new settings to the RSS-131.



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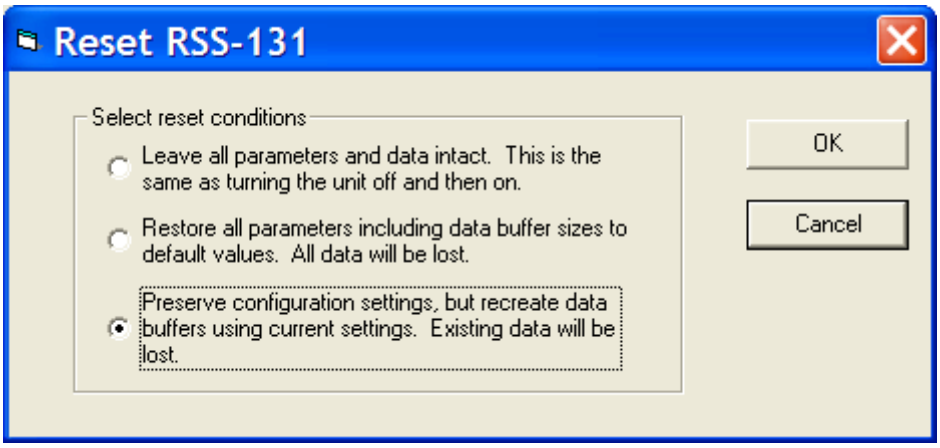
At this point, the RSS-131 is still using its original data buffers. The unit must be reset with a special command to resize the data buffers. This is done by selecting the option shown below.

**NOTE:** Selecting any option other than the one shown below will result in the change not taking effect.


Reset RSS-131
Select reset conditions
Leave all parameters and data intact. This is the same as turning the unit off and then on.
Restore all parameters including data buffer sizes to default values. All data will be lost.
Preserve configuration settings, but recreate data buffers using current settings. Existing data will be lost.
OK
Cancel

Once this is complete, the unit will operate the same as the older units.



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# An Explanation of Data Buffer Operation

A detailed example of data buffer operation provides a more thorough understanding of how the RSS-131 operates when backward compatible commands are used. This example assumes the unit is configured for 10,000 radiation values (the default value) and M0 commands are used to retrieve data.

The M0 command retrieves the first 500 data points in the buffer. This means the first 500 points will be transmitted until the entire buffer (10,000 values in this example) is full.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **1** | **2** | **3** | **4** | **5** | **...** | **499** | **500** |

**Data sent from RSS-131 with #M0 command when 500 values are recorded**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **1** | **2** | **3** | **4** | **5** | **...** | **499** | **500** |

**Data sent from RSS-131 with #M0 command when 10000 values are recorded**

Once the buffer is full and additional data values are recorded, the oldest values are shifted out of the buffer while the new ones are recorded at the end of the buffer. This means the correct data will be transmitted while values 10,001 through 10,500 are recorded.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **2** | **3** | **4** | **5** | **6** | **...** | **10000** | **10001** |

**Data sent from RSS-131 with #M0 command when value number 10001 is recorded (oldest point is lost)**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **3** | **4** | **5** | **6** | **7** | **...** | **10001** | **1002** |

**Data sent from RSS-131 with #M0 command when value number 10002 is recorded (two oldest points are lost)**

The RSS-131 will continue to transmit values 10,001 through 10,500 as shown below until the buffer fills up again.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **10001** | **10002** | **10003** | **10004** | **10005** | **...** | **10499** | **10500** |

**Data sent from RSS-131 with #M0 command when value number 10500 is recorded**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **10001** | **10002** | **10003** | **10004** | **10005** | **...** | **10499** | **10500** |

**Data sent from RSS-131 with #M0 command when value number 10501 is recorded**



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# Backward Compatibility Commands ("A, "D", "E", "L", "M", and "S")

The commands in this section maintain backward compatibility with the obsolete RSS-121 and RSS-1013 systems. **They should not be used in new systems.**

These commands primarily transmit an average exposure rate value upon request. This average is determined by storing each 1-second sample into an integrating accumulator. When a request is made, the average exposure rate is computed and transmitted. Depending on the command the accumulator may be reset which will start a new averaging period.

## Command Format

The "D", "E", and "L" commands use the same format:

#CY<CR>

\# - "#" Character (ASCII Code 42)

C - Command Character

Y - Unit Address

<CR> - Carriage Return Character

The valid command characters are:

D - (Data Command, Reset Accumulators)

E - (Data Command, Do Not Reset Accumulators)

L - (Last Data Command)



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# "D" or Data Command (with reset)

This command calculates the exposure rate and transmits it along with other system information. After responding, the data accumulators are reset, and begin a new data-averaging period. The response is:

D Y M SSSS HHHH BB.BB AAAAA EEEE CC<CR><LF>

D - Command

Y - Unit Number

M - Not Used (always 0)

SSSS - Status Information (See Table 6)

HHHH - 0000 (Not Used)

BB.BB - Battery Voltage

AAAAA - Sensor Data in mR/h.

EEEE - Minutes the Unit Has Been Averaging

CC - Check Sum - Sum of All Digits not including the "D" or "Y" Nor the Check Sum Itself

<CR> - Carriage Return

<LF> - Line Feed

| STATUS DIGIT | DESCRIPTION | MEANING OF DIGIT |
|---|---|---|
| 1 (rightmost) | CPU STATUS | 0 = OK 1 = ERROR |
| 2 | A/D STATUS | 0 = OK 1 = ERROR |
| 3 | BATTERY STATUS | 0 = OK 1 = LOW (<6.0 V) |
| 4 | ALARM FLAG | 0 = NO ALARM 1 = ALARM |

**Table 6: Meaning of Status Flags**



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## "E" or Data Command (without reset)

The "E" command begins the computation of a new radiation exposure rate, similar to the "D" command, but does not reset the data accumulators following data transmission. The response format is identical with the "D" command except that the "D" is replaced by "E".

## "L" or Data Command.

The "L" command retransmits the last "D" or "E" response. This is useful in case of a transmission error.

NOTE: The "L" command allows a review of the data shown on the previous "D" command, since no new average is computed.

The response format is identical with the "D" response except the "D" is replaced by an "L".



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# A Commands

The "A" commands instruct the unit to set or change a system parameter. The request format is:

#AYNXXXXX<CR><LF>

# - "#" Character (ASCII Code 42)

A - Command

Y - Unit Address

N - Secondary Command (see below)

XXXXX - Data

<CR> - Carriage Return

<LF> - Line Feed

## "4" Set Storage Period

The RSS-121 can store 500 data points that can be transmitted upon request. Each data point is an average over a specified period, which is set using this command. The transmitted data must be a five digit number representing seconds with leading zeros and equal to one of the following numbers: **5, 10, 15, 30, 60, 120, 300, 600, 900.** These numbers correspond to the integration time of each of the 500 data points in seconds. For example, if 30 seconds (1/2 minute) is chosen, the 500 data points will coincide to a total of 250 minutes.

For example, the following sent to the remote would set the storage period to 60 seconds.

**#A0400060<CR>**

## "6" Reset

This function provides a method of resetting the unit remotely. To prevent an accidental reset the command must be sent with the data field containing "12345". For example, if the unit address is '0' the complete command would be:

**#A0612345<CR>**

Following reset the remote will echo back with the command acknowledging the request followed by the unit reset.

**NOTE:** *Caution should be used when sending this command since all setups will revert back to their defaults and data buffers will be cleaned. It will not affect the data cartridge, however, except data recording must be re-initiated.*

## "7" Set Phone Number



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This command sets the phone number that will be dialed if a unit alarm condition is present. This feature is only available if a Hayes compatible modem is installed and the modem connected to the dial-up phone network. An example of the command to dial 216/425-3755 is:

**#A072164253755<CR>**

The unit will echo the command and new phone number confirming its acceptance. To disable the automatic dial send this command with no phone number as shown below.

**#A07<CR>**

# M Commands

The "M" command is used to transmit data from the buffer and clear it once data has been transmitted. The "M0" command transmits data and "M1" clears the buffer. To send either M0 or M1 the following format is used.

**#MY<CR><LF>**

## "M0" Command (Send Buffered Data)

The "M0" command transmits the entire data buffer (maximum 500 points) to the interrogating device. The response format is:

**00125 00015 0000 0000 06.80 00.00 00.00 00028<CR>**

**.0125 .0122 .0136 .0142 .0137 .0129 .0130 .0131 .0131 .0127 00077<CR>**

**.0127 .0126 .0132 .0131 .0140 .0135 .0130 .0122 .0122 .0127 00068<CR>**

. . . . . .

. . . . . .

. . . . . .

. . . . . .



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The length to this response depends upon how many data points the buffer contains Once all data points in the buffer are filled, each new data point pushes out the oldest data point, thereby maintaining the most current 500 data points (assuming the buffer is configured correctly – see description above). The first line of the response contains the number of data points to be transmitted, followed by the averaging time in seconds per point. The "0000" is the unit status, 6.80 will be the current battery voltage. The next numbers are always "00.00". The remaining lines are the data, transmitted ten numbers per line until all data has been transmitted. The check sum at the end of each line is equal to the addition of all numbers in that line, ignoring decimal points and spaces. This feature insures detection of data transmission errors.

## "M1" Command (Reset Memory Buffers)

The "M1" command format is identical to the "M0" command but will reset the data buffer. The response to this command is:

**MY<CR><LF>**

This command is important since the data buffer must be cleared after data has been received in the older units.



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# S Commands

The "S" command requests sensor data. The remote station converts the sensor data to engineering units. The response format is:

**SYNSSSSS<CR><LF>**

S - Command

Y - Unit Address

N - Secondary Command Number

SSSSS - Data with a Floating Decimal Point

<CR> - Carriage Return

<LF> - Line Feed

The following table briefly references each of these commands and the following sections detail their function of each.

DATA TRANSMITTED IN RESPONSE TO AN "S" COMMAND

| SECONDARY COMMAND | DATA TRANSMITTED |
|---|---|
| 0 | NEW RADIATION DATA(WITH RESET) |
| 1 | LAST RADIATION DATA |
| 7 | INTEGRATION TIME |
| 8 | NEW RADIATION DATA (NO RESET) |

## "0" New Radiation Data

The transmitted sensor data is the average since the last "0" command. If data requests are made at 5 minute intervals, the data will be a 5 minute average. If data is requested at 1 minute intervals, the data will be a 1 minute average. A decimal point will be located in the five character field and will float as appropriate. Once the "0" command is executed and the data computed and transmitted, the internal registers are reset in preparation for a new averaging period. If a transmission error occurs, the "1" command will request the same data be retransmitted.

## "1" Last Radiation Data

The response to the "1" command is similar to the "0" command. The data is a retransmission of the exposure rate calculated from the last "0" command. This function is useful if the original data is garbled due to a transmission error. As with the "0" command, the five character field will contain a floating decimal point.



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## "7" Integration Time

The "7" command will request how long the unit has been averaging data. The time is transmitted in the minutes that the unit has been integrating the exposure rate average. The time is multiplied by the exposure rate average to compute the accumulated exposure.

## "8" New Radiation Data (No Reset)

The "8" command is identical with the computed new sensor command described earlier except the data accumulators are not reset following the transmission of data.

**Note**: Commands 2, 3, 4, 5, 6 are not used.



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# Internal Options

## Pressure Sensor

The board supports an optional pressure sensor for determining barometric pressure. The pressure sensor has a range of 600 to 1100 mBar. The output of the sensor is between .1V (for 600 mBar) and 5.1V (for 1100 mBar). This sensor is located inside the enclosure and connects to the board on J7. The values recorded in the data queue are in psia.

The voltage from the sensor first passes through a resistive divider network. This must be accounted for in the calculation. The equation that converts voltage output by the sensor to psia is shown here for reference.

$V_{sensor} = VA_{/D} * 3$ ... account for 1/3 divider network

$Millibar = ((V_{sensor} - .1) * 60 + 600)$ ... account for output voltage

$Psia = Millibar * .014504$ ... conversion factor



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# Modem

The RSS-131 supports an optional 33,600 baud modem operating as COM3. This modem is initialized in auto-answer mode with 8 data bits, 1 stop bit and no parity. The modem will always answer incoming calls. The board may also be configured to dial a remote phone if an alarm is generated. See Table 5 for details. If the modem is not installed COM3 is not used.

The modem does not echo characters as they are entered. If the user wants to see characters as they are typed it is his responsibility to put the modem on the remote computer in half-duplex mode.



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# External Options
## Serial Displays

The RSS-131 supports external serial displays which support straight ASCII data with no escape sequences. These displays are supported only in firmware versions 4.0 and higher. The Configuration Utility must be version 3.6 or later.

The following display kits are supported:

- **S131-ESD-001** 1 line by 10 character LED marquee display kit, containing
    - **S131-232-003** Serial Display Cable
    - **DSP1-1** 1 line by 10 character LED marquee display
- **S131-ESD-002** 1 line by 20 character LED marquee display kit, containing
    - **S131-232-004** Serial Display Cable
    - **DSP1-2** 1 line by 20 character LED marquee display
- **S131-ESD-003** 1 line by 10 character LED marquee display kit, containing
    - **S131-232-005** Serial Display Cable
    - **DSP1-3** 1 line by 10 character LED marquee display
    - **DEV27-1** RS-232/RS-485 converter

The kits provide both the display and the serial cable required to communicate with it. The RSS-131 can be configured to display radiation values (in R/hr or Sv/hr) on the display. It will not display other sensor values.

The display is not weatherproof and must be mounted in a customer-supplied weatherproof case if it is to be used outdoors.

For additional details regarding the external displays please refer to the appendices at the end of this manual.



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# RSS-131 Configuration Utility

## Overview

The RSS-131 can be configured be entering the commands on any serial terminal. This requires the user be familiar with the serial protocol used by the RSS-131. A more convenient way of configuring the RSS-131 is through the RSS-131 Configuration Utility. This utility works with both the RSS-131 and the lower range RSS-131.

When the configuration utility starts all configuration parameters are set to default values. These are local values stored only on the PC at this point. These values are not sufficient for accurate radiation readings in every system. The offsets and gains of the electrometer vary by system and are determined during calibration. For this reason the configuration utility attempts to upload parameters from the RSS-131 on startup. The values uploaded from the RSS-131 overwrite the default values in the PC. This prevents the user from changing one parameter but not all of the electrometer constants and sending default values to the RSS-131.

The configuration utility allows users to modify parameters and then store them to disk or download them to the RSS-131. In addition to configuration a number of online functions are provided. These include setting of the RSS-131 real time clock, display of the sensor values in real time, and downloading new firmware to the unit (a programming cable is required to reprogram the RSS-131 firmware).

## Modem Support

The configuration utility supports modems for remote access starting with version 2.2.0. This allows parameters to be changed from a central site without traveling to remote sites. Once a connection is made to the RSS-131, all online functions are accessed exactly as though the connection was over a standard serial cable. The connection is made through the Modem menu items.



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# Installation

The RSS-131 Configuration Utility is installed by running the SETUP.EXE program on the CD. This file should be found in a directory named "RSS-131 Cfg Util ver x.xx" where "x.xx" is the version number of the utility shipped on the CD. By default the application will install to the "C:\Program Files\RSS131 Configuration Utility" directory. This location may be overridden to specify a different drive or directory.

When setup begins a welcome dialog box will appear (see Figure 8).

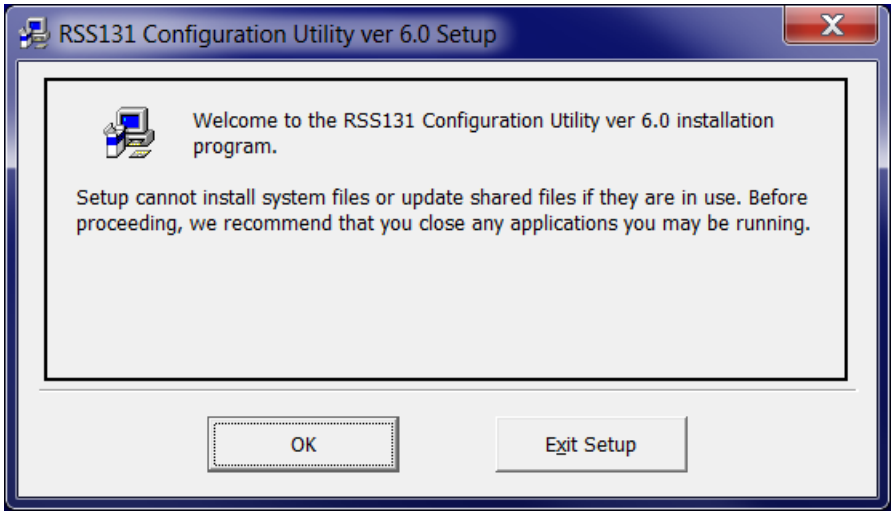
RSS131 Configuration Utility ver 6.0 Setup
Welcome to the RSS131 Configuration Utility ver 6.0 installation program.
Setup cannot install system files or update shared files if they are in use. Before proceeding, we recommend that you close any applications you may be running.
OK
Exit Setup

**Figure 8: RSS-131 Configuration Utility Welcome Dialog Box**

Clicking the OK command button will display another dialog box that allows the user to change the installation drive and directory (see Figure 9). To change the installation location click on the "Change Directory" command button and specify a new location. To install the application click on the icon in the upper left portion of the dialog box.

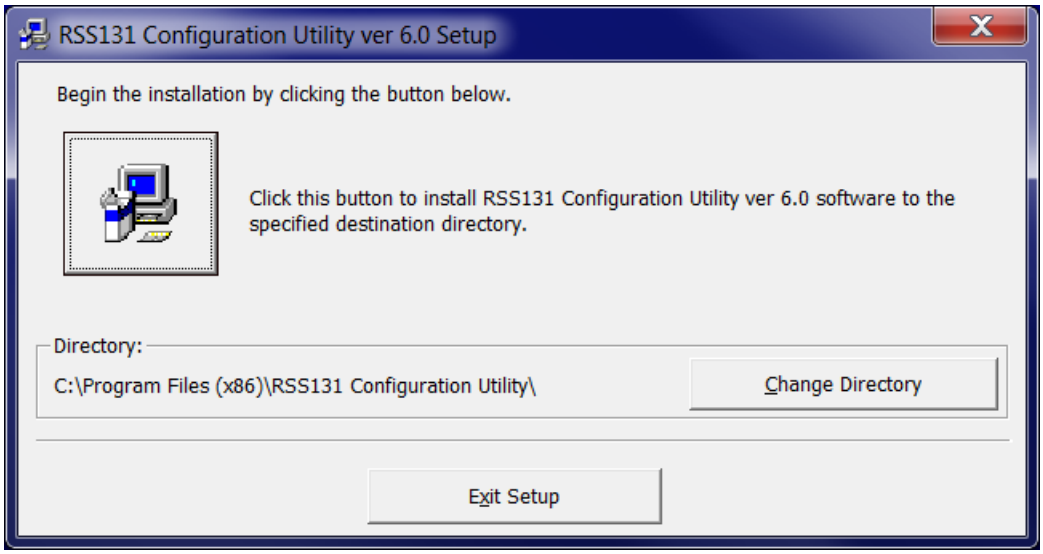
RSS131 Configuration Utility ver 6.0 Setup
Begin the installation by clicking the button below.
Click this button to install RSS131 Configuration Utility ver 6.0 software to the specified destination directory.
Directory:
C:\Program Files (x86)\RSS131 Configuration Utility\
Change Directory
Exit Setup

**Figure 9: RSS-131 Configuration Utility Installation Location**

The user will then be prompted for a program group which will contain the shortcut to the RSS-131 Configuration Utility from the Start Menu (see Figure 10). This will default to the



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"RSS131 Configuration Utility" program group. Click the Continue command button to install into the specified program group.

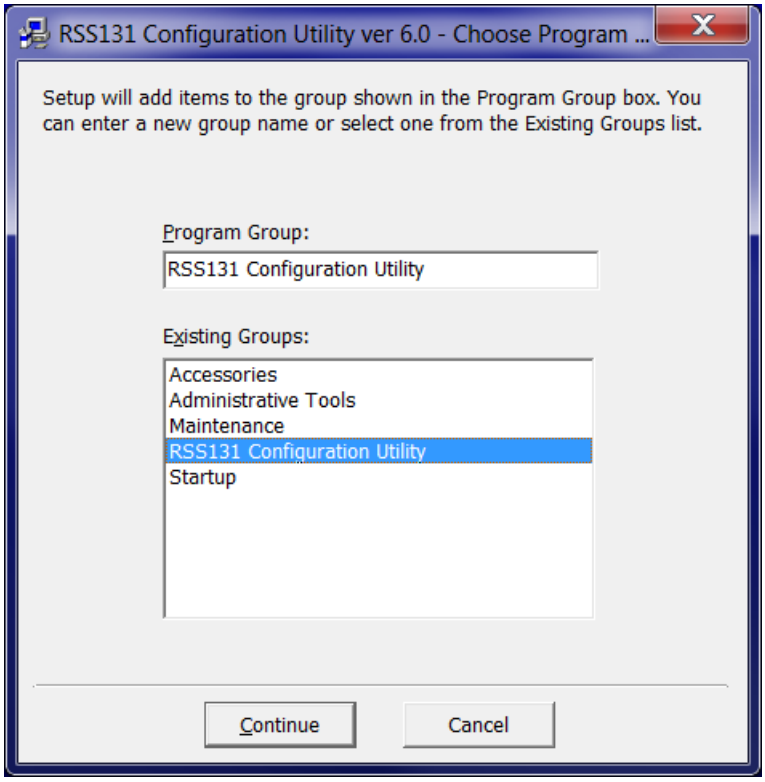
RSS131 Configuration Utility ver 6.0 - Choose Program ...
Setup will add items to the group shown in the Program Group box. You can enter a new group name or select one from the Existing Groups list.
Program Group:
RSS131 Configuration Utility
Existing Groups:
Accessories
Administrative Tools
Maintenance
RSS131 Configuration Utility
Startup
Continue
Cancel

**Figure 10: RSS-131 Configuration Utility Program Group**

Once the Continue command button is clicked the application will be installed. If an error message appears indicating the file MSVCRT.DLL is in use and cannot be replaced click Ignore. The program will install successfully and run with no problems.

## Command Line Parameter to Specify COM Port

The RSS-131 Configuration supports a single command line parameter beginning in version 6.0. The parameter takes the form

/x

where x can be any number between 1 and 9 inclusive. If specified this causes the program to use COMx on the PC, thereby overriding the last saved COM port value. This is useful on newer machines that use USB to serial adapters to provide serial ports.

For example, /4 would instruct the program to use the PC COM4 port.

The complete shortcut would look as follows in this case:

**"C:\Program Files (x86)\RSS131 Configuration Utility\RSS131Config.exe" /4**



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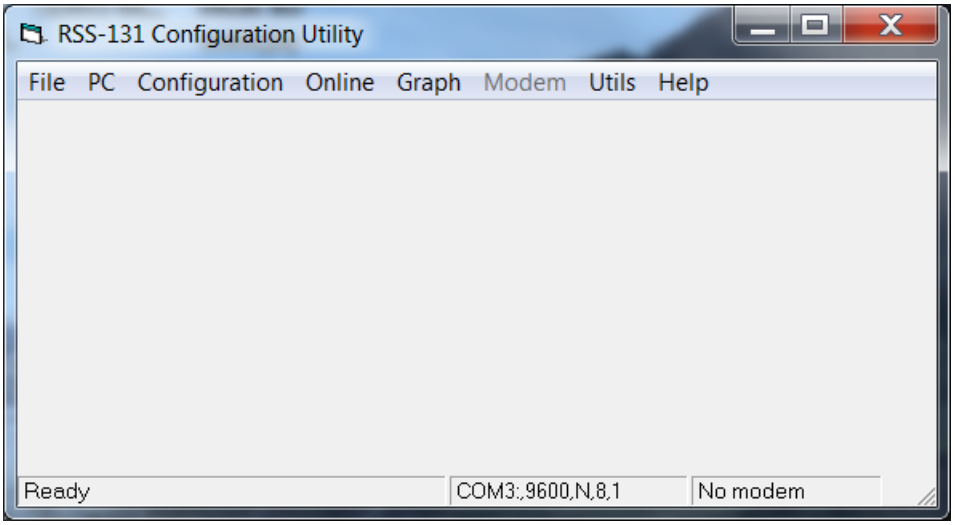


The **File** menu functions are:

| | |
|---|---|
| **Default Configuration** | Create a new configuration. All parameters are set to their default values. |
| **Read** | Read a configuration file previously stored using the Save function. |
| **Save** | Save the current unit configuration to a file. |
| **Save As** | Save the current unit configuration to a file under a new name. |
| **Exit** | Exit the program. |



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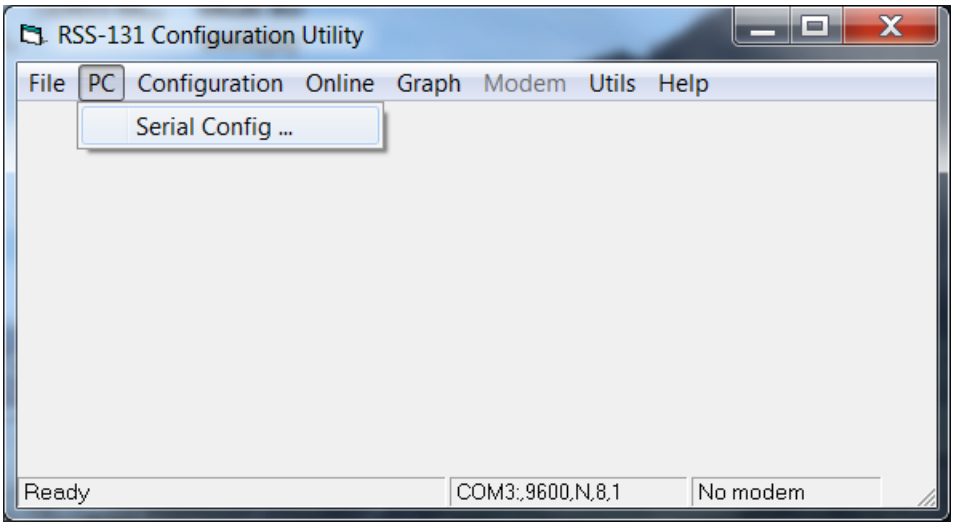
# PC Menu

The PC menu is where PC communication parameters are configured as well as which COM port on the RSS-131 is connected to the PC.

Each of these parameters is critical to successful communications. The PC port specified must match the actual port being used to communicate with the RSS-131. The PC baud rate and parity must be set to match the same parameters on the RSS-131 COM port.

The RSS-131 COM port used to communicate with the PC must also be correctly identified. This is used if configuration parameters are downloaded from the PC to the RSS-131. When serial parameters are sent from the PC to the RSS-131 the RSS-131 changes baud rate, data bits and parity immediately upon receiving these new values. This means the PC must also change its serial parameters to match the RSS-131. If the incorrect RSS-131 COM port is specified the wrong serial parameters will be used when reinitializing the PC COM port.

When configuration parameters are downloaded to the RSS-131 the PC will automatically changes its serial configuration to match the RSS-131. No user intervention is required. For example, if the PC and RSS-131 are currently configured for 9600,n,8,1 operation but the user wants to change parity to even he would specify this on the Configuration...Communications screen. No changes would be made on the PC...Serial Config screen. COM settings would not be changed until configuration parameters are downloaded to the RSS-131.



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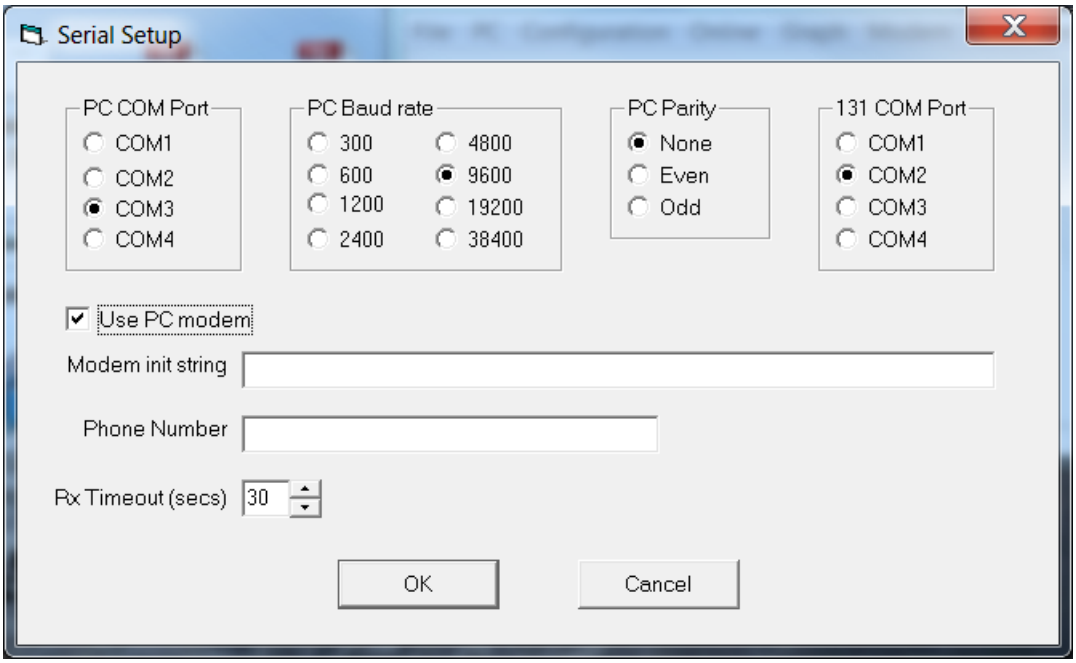
# Serial Config




The **Serial Config** dialog box functions are:

| | |
|---|---|
| **PC COM Port** | Selects which COM port on the PC is connected to the 131. Version 6.0 and later of the RSS-131 Configuration Utility support COM1-COM9, while earlier versions only support COM1-COM4 as shown above. |
| **PC Baud Rate** | Specifies the baud rate between the PC and 131. This must match the baud rate specified on the 131 for its COM |
| **PC Parity** | Specifies the parity between the PC and 131. This must match the parity specified on the 131 for its COM port |
| **131 COM Port** | Specifies which COM port on the 131 is connected to the PC via serial cable. This must be specified correctly for downloading parameters to the 131. |
| **Use PC Modem** | This checkbox determines if a modem is to be connected. It must be checked if a modem is used. If unchecked, the modem init string and phone number fields will be hidden. |
| **Modem Init String** | Optional string which will be sent to modem when it is initialized |
| **Phone Number** | This is the phone number which will be dialed from the modem. |
| **Rx Timeout** | This is the receive timeout when the modem is used. This allows the user to compensate for slow or poor quality phone lines. |



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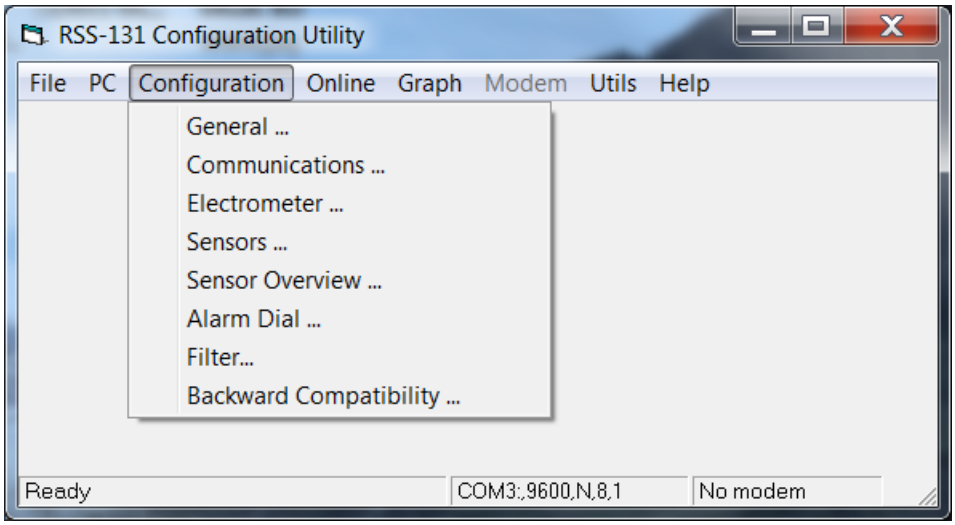
# Configuration Menu

The configuration menu selection organizes the system parameters into function groups. Each of these groups allows modification of unit parameters as described in more detail below.



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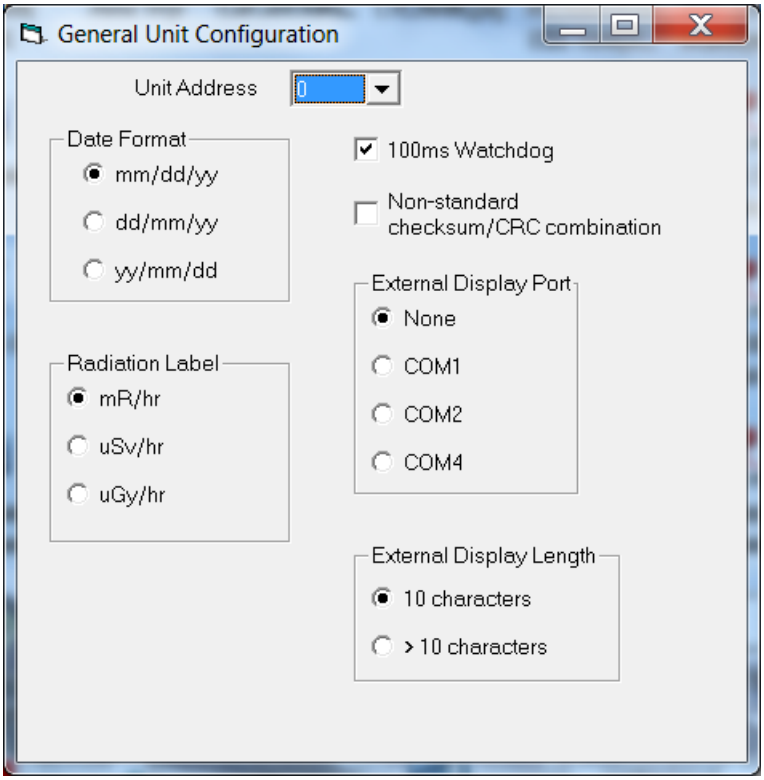
# General




The **General** dialog box functions are:

| | |
|---|---|
| **Unit Address** | Sets the units address. Choices are from 0 to 99 |
| **Time Format** | Specifies how dates are input and displayed. The PC must match the RSS-131 date format **exactly**. |
| **Radiation Label** | This option determines what label is displayed on the Online…Current Data window when radiation data is displayed. It changes only the label; it does not cause any numerical conversion to occur. This also determines which text labels are displayed on the external serial display if one is used. |
| **100 ms Watchdog** | Checking this box enables the 100 ms watchdog timer. The watchdog timer is not actually enabled in the 131 until parameters are downloaded and the 131 restarted (refer to WDE description in Configuration Commands for details) |
| **Non-standard checksum/CRC** | This places a 4 byte checksum/CRC combination at the end of each data string sent from the RSS-131 instead of the standard, backward-compatible 4 byte sum of ASCII characters. |
| **External Display Port** | This specifies which serial port on the RSS-131 is attached to the external serial display. COM3 is not supported because it is dedicated to the internal modem. |
| **External Display Length** | If an external display is selected this determines how many |



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characters are sent to the display. In any case a single line display is assumed. If > 10 characters is selected a 20 character string will be displayed.



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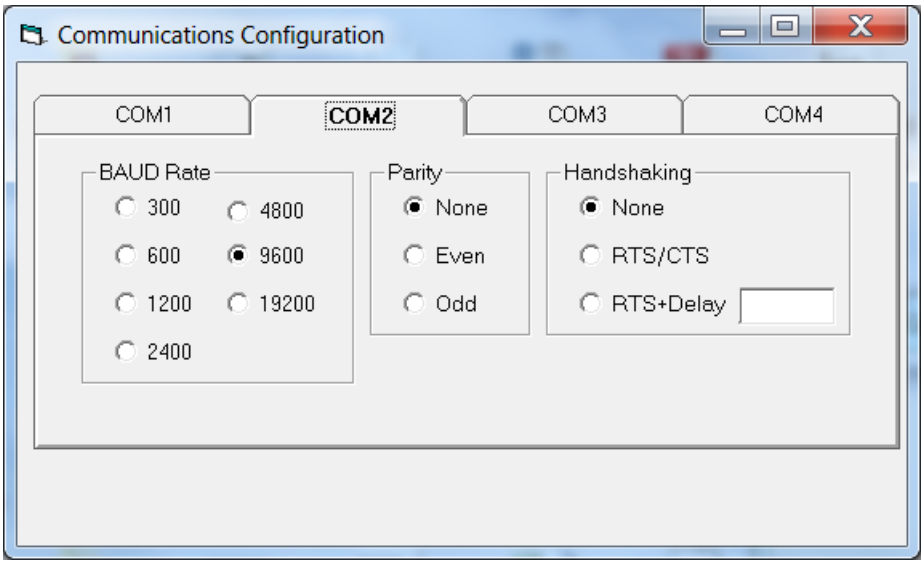
# Communications Configuration




The 131 **Communication** dialog box functions are shown below. Note that the COM ports vary in their support for some features. Not all those features listed below are available on all ports.

| | |
|---|---|
| **BAUD Rate** | Sets the transmission speed for the port. |
| **Parity** | Selects Even, Odd , or No parity. |
| **Handshaking** | Sets handshaking protocol for the port. RTS/CTS causes the RSS131 to activate RTS and wait for CTS active before sending data. RTS+Delay will cause the RSS131 to raise RTS and then transmit data regardless of whether or not CTS is active. In this case there is a delay between RTS going active and data transmission. This delay is specified in milliseconds in the text box associated with this option. |



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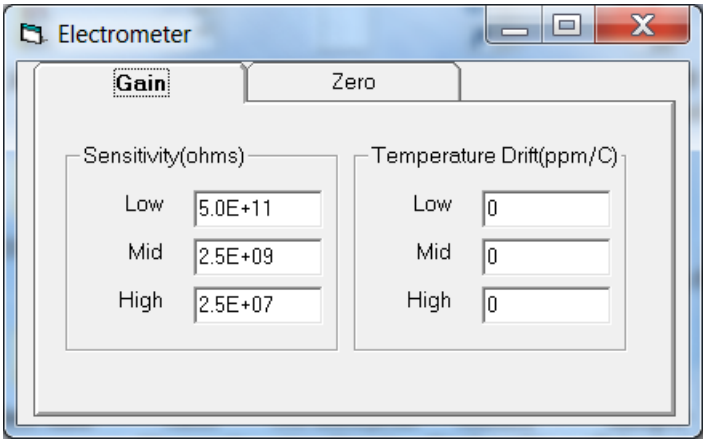
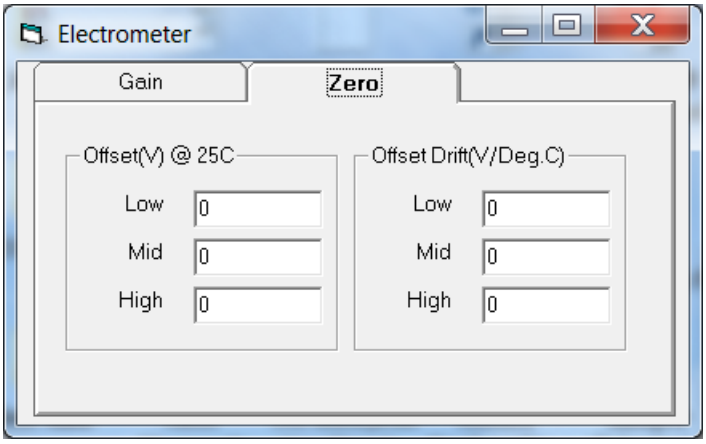
# Electrometer

The electrometer is characterized by a number of parameters that represent its operation over temperature. These are divided into 2 sections (Gain and Zero) and are shown in the following 2 screens. The values which are displayed in these screens are unique to each unit. The values will be found on the calibration sheets received from Reuter Stokes.




The **Electrometer/Gain** dialog box functions are shown below

| | |
|---|---|
| **Sensitivity** | Effectively this is the nominal feedback resistor values at 25°C for each of the 3 ranges. |
| **Temperature Drift** | Temperature drift of the resistors in ppm/°C. |




The **Electrometer/Zero** dialog box functions are.

| | |
|---|---|
| **Offset** | The electrometer zero values at 25°C for each of the 3 ranges. |
| **Offset Drift** | Zero drift of the zero in Volts/°C. |



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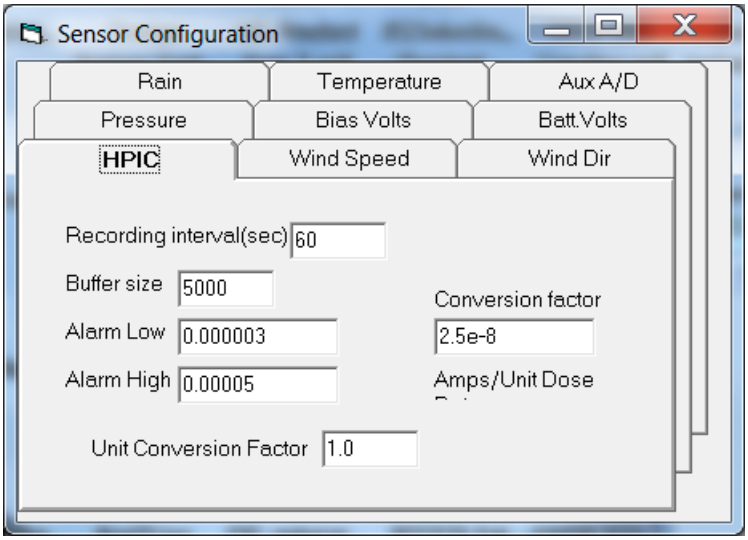
# Sensor Configuration

Each sensor in the system has a tabbed dialog box. All sensors have a recording interval, buffer size and alarm settings. HPIC, rain, and wind speed also have conversion factors.




The **Sensor Configuration** dialog box functions are:

| | |
|---|---|
| **Recording Interval** | Number of seconds between recording data to the buffer. |
| **Buffer Size** | Number of points allocated to the sensor buffer (this does not take effect on the RSS-131 until the RSS-131 is restarted). |
| **Alarm Low** | Low alarm value (0 to disable) |
| **Alarm High** | High alarm value (0 to disable) |
| **Conversion Factor** | Converts sensor input to engineering units. Only used for HPIC, Rain and Wind Speed. |
| **Unit Conversion Factor** | This is used only on for radiation (HPIC). When radiation data is displayed on the Online...Sensor Data the value displayed in the radiation value in uR/hr multiplied by this value. |
| **Range** | This is used only for the pressure sensor. There are two supported pressure sensors (600-1100 hPa/mbar and 800-1100 hPa/mbar). |



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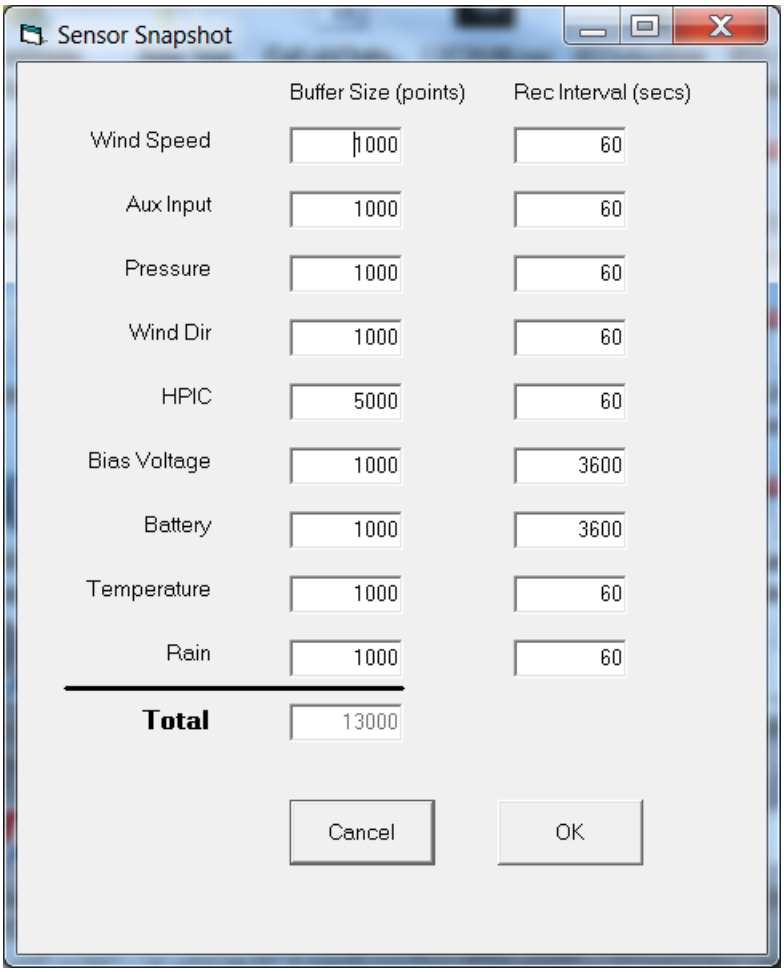
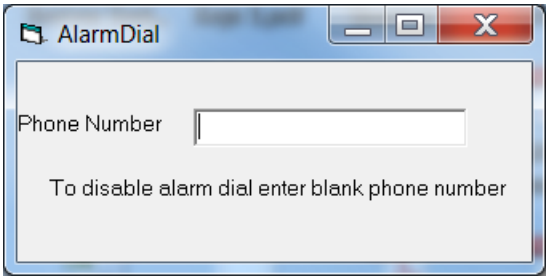
# Sensor Overview

This window provides a quick way to configure buffer size and recording interval for all sensors without having to change between tabs. As always, if buffer sizes are changed the unit must be reset for these changes to take effect (refer to Reset RSS-131 on page 83).




# Alarm Dial

In the event of an alarm condition a phone number can be dial. This is only available on units with phone modems.



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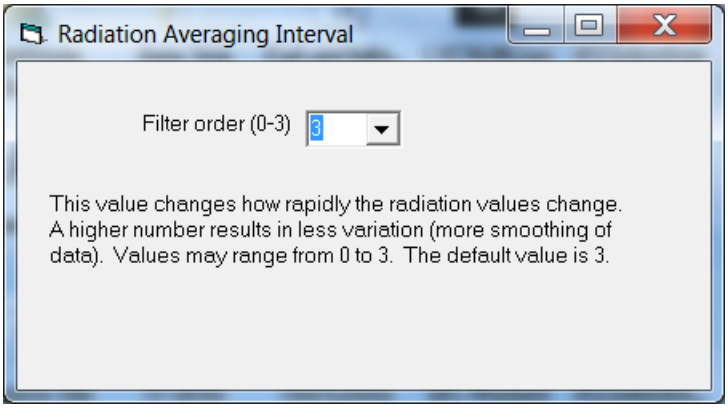
The **Alarm Dial** dialog box functions are.

| | |
|---|---|
| **Phone Number** | Phone number to dial in the event of an alarm. Can include ',' for delay. |

# Filter

A software filter is used to smooth radiation values. This filter uses a constant that can be from 0 to 3. A higher number results in more filtering and a smoother radiation response. A value of 0 results in nearly instantaneous results without smoothing. The default value is 3.


Radiation Averaging Interval
Filter order (0-3)
3
This value changes how rapidly the radiation values change. A higher number results in less variation (more smoothing of data). Values may range from 0 to 3. The default value is 3.



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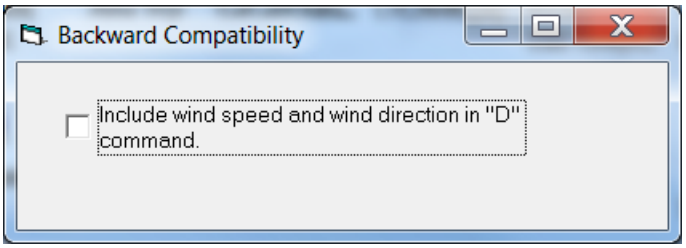
# Backward Compatibility

The option presented under this menu is for use only when the RSS-131 is integrated into a network which also contains older radiation monitoring units from Reuter Stokes (RSS-1012, RSS-1013, RSS-121) which use the older "D" command. There are two versions of the "D" command in the older units. The default version used by most systems returns the battery voltage, bias voltage, sampling interval and radiation value. However, some systems used a different version which returned wind speed, wind sensor, battery and radiation values. This option determines which version of the "D" command is used.



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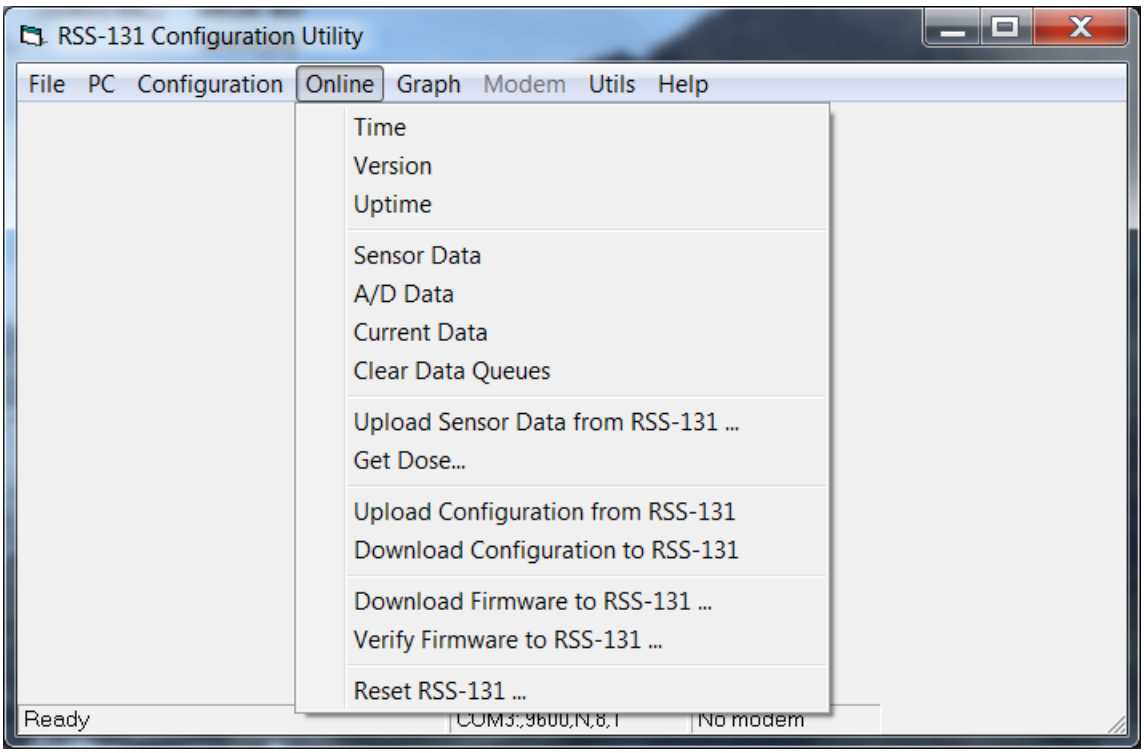
## Online Menu

All functions which communicate directly with the RSS-131 are found in the Online menu with the exception of modem functions.



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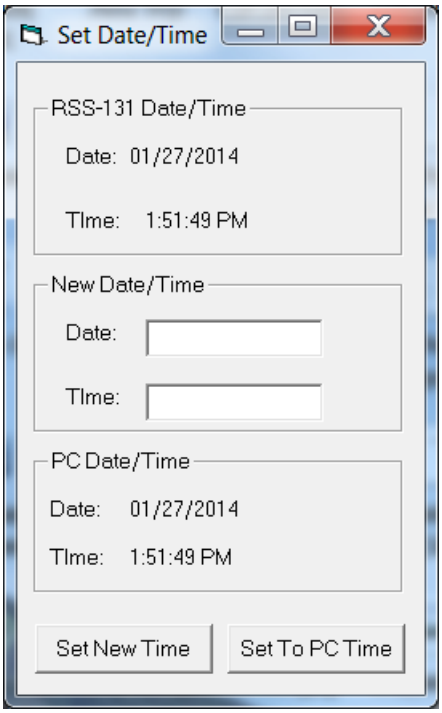
# Time

This dialog box provides 2 methods for setting the RSS-131 real time clock. First is to enter the date and time, and second to synchronize the RSS-131 with the PC clock.




To synchronize the PC and RSS-131 clocks press the **Set To PC Time** button. To set a different time enter the new date and time in the edit windows provided in the **New Date/Time** section and press the **Set new Time** button.

**NOTE:**

The RSS-131 supports mm/dd/yy, dd/mm/yy, and yy/mm/dd formats. The format specified in the RSS-131 must **exactly** match the PC format specified in the Regional Settings available from Control Panel on the PC. If these are not matched an incorrect (possibly invalid) date will be set in the RSS-131. Also, the RSS-131 does not support a '-' as the separator between month, day and year, so a '/' must be specified in the PC Regional Settings as the date separator.



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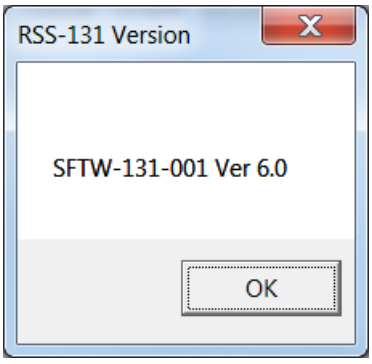
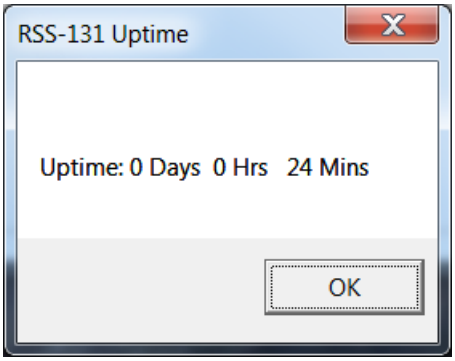
# Version

Selecting this option will retrieve and display the version string from the 131 firmware. No dialog box appears until the version string is retrieved or the communications fail.




# Uptime

This option displays the elapsed time since the RSS-131 was last reset.



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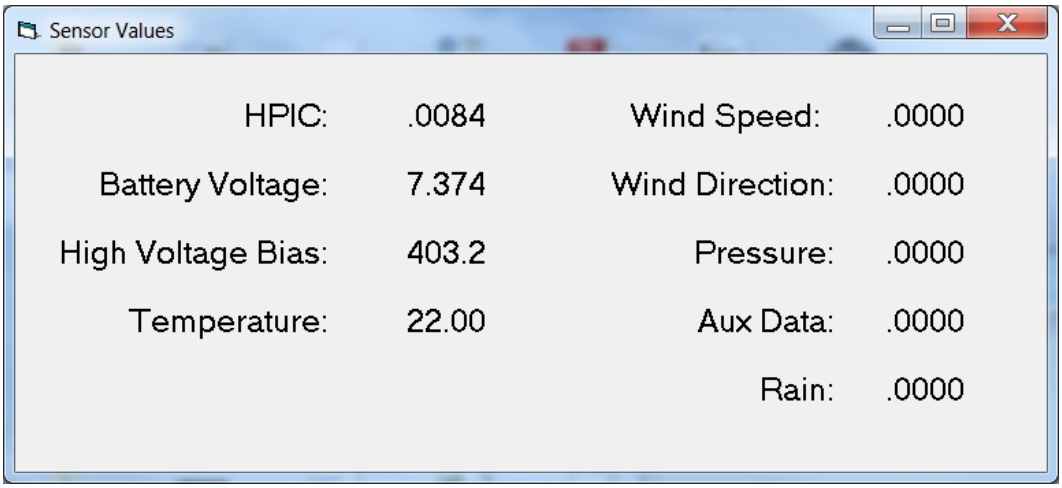
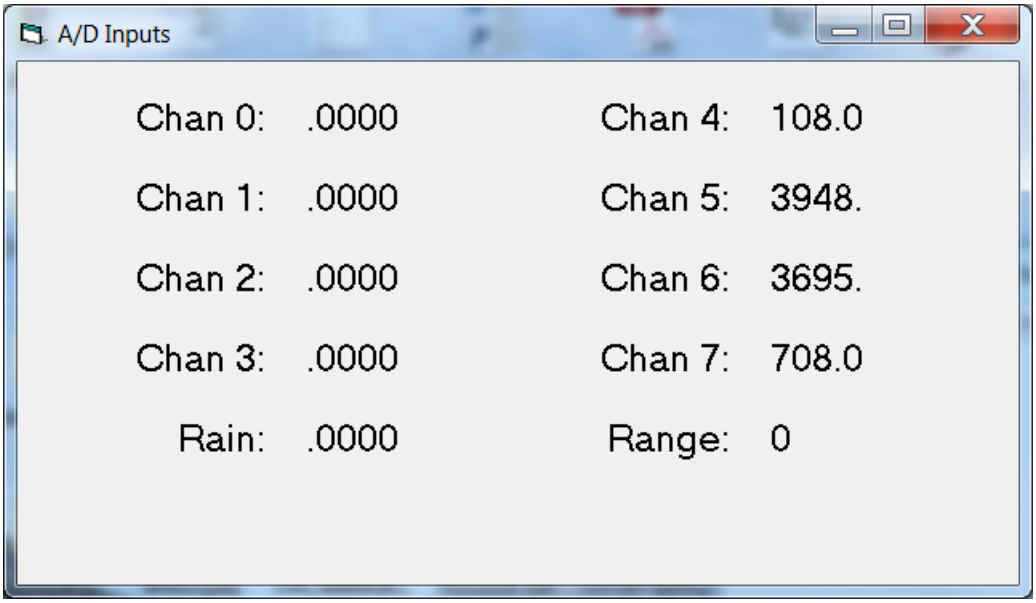
# Sensor Data

The sensor data screen will continuously display the sensor data. This data is in engineering units. Data will update once per second. To terminate this display press the X in the upper right hand corner of the window.




# A/D Data

The A/D output window is similar to the sensor data except it displays the raw A/D values. To terminate this display press the X in the upper right hand corner of the window. The range shown on this screen is the electrometer range. Valid range values are 0 (low range), 1 (mid range) and 2 (high range).



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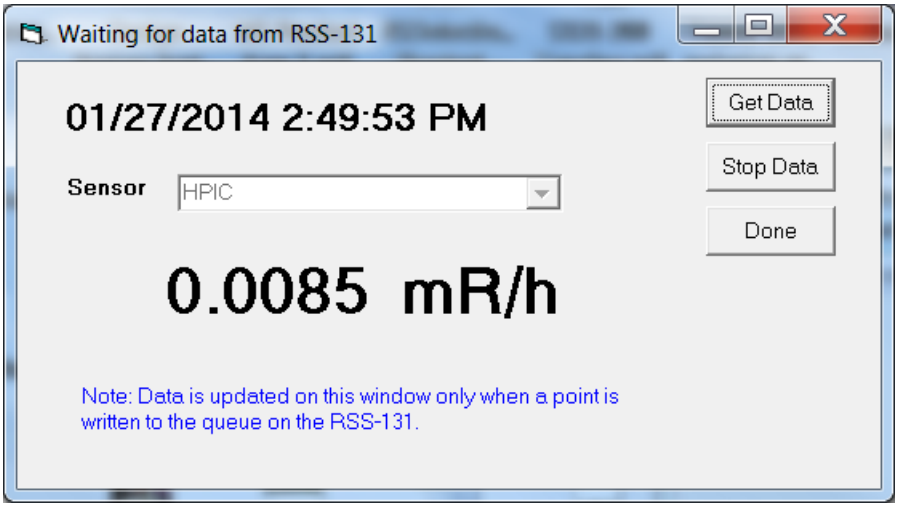
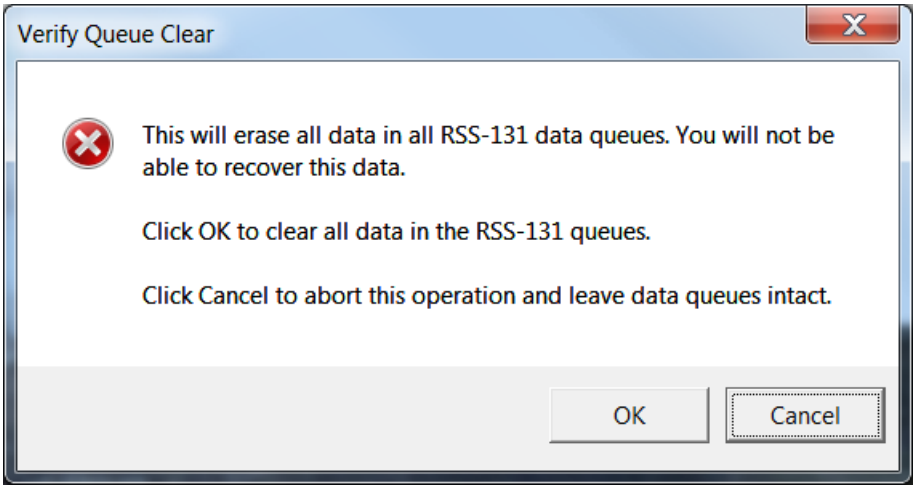
# Current Data

This option allows the user to display in large text the value for one sensor as it is written to the queue in the RSS-131. This means if the recording interval for a sensor is one minute in the RSS-131, this display will also update once per minute. Once the sensor is selected the user must click the Get Data command button to start updating the display. Clicking the Stop Data command button will stop display updates. For radiation data the value displayed is the uR/hr received from the RSS131 multiplied by the Unit Conversion Factor from the Configuration...Sensors...HPIC screen. The radiation label displayed is determined by the Configuration...General...Radiation Label option.


Waiting for data from RSS-131
01/27/2014 2:49:53 PM
Get Data
Stop Data
Done
Sensor
HPIC
0.0085 mR/h
Note: Data is updated on this window only when a point is written to the queue on the RSS-131.

# Clear Data Queues

This option allows the user to clear all data from all queues in the RSS-131. Once this is done there will be no historical data remaining in the RSS-131. For this reason the user is prompted to make sure this is what is to be done. The message box shown here will appear.


Verify Queue Clear
This will erase all data in all RSS-131 data queues. You will not be able to recover this data.
Click OK to clear all data in the RSS-131 queues.
Click Cancel to abort this operation and leave data queues intact.
OK
Cancel



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To clear all data queues the user should click OK. Otherwise, the user should hit Cancel to preserve all data points in the RSS-131.



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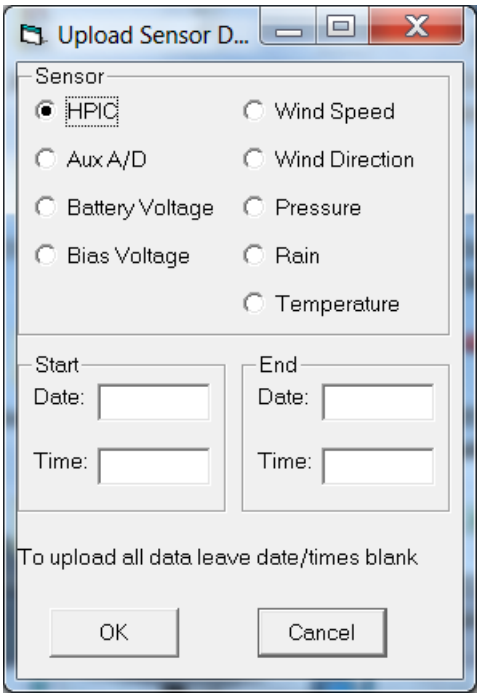
# Upload Sensor Data

This selection provides the ability to upload data for a sensor to a comma delimited file that is compatible with Excel and other third party programs. Following selection of the menu item the following dialog box will be displayed.




The **Upload Sensor Data** dialog box functions are.

| | |
|---|---|
| **Sensor** | Select the sensor whose data will be uploaded. |
| **Start** | Start date and time of data |
| **End** | Ending date and time of data |

**Note**: To download all data in the RSS-131 buffer leave the starting and ending date and time blank. If a start date and time are specified an end date and time must also be specified.

**NOTE:**

The RSS-131 supports mm/dd/yy, dd/mm/yy, and yy/mm/dd formats. The format specified in the RSS-131 must **exactly** match the PC format specified in the Regional Settings available from Control Panel on the PC. If these are not matched an incorrect (possibly invalid) date will be set in the RSS-131. Also, the RSS-131 does not support a '-' as the separator between month, day and year, so a '/' must be specified in the PC Regional Settings as the date separator.



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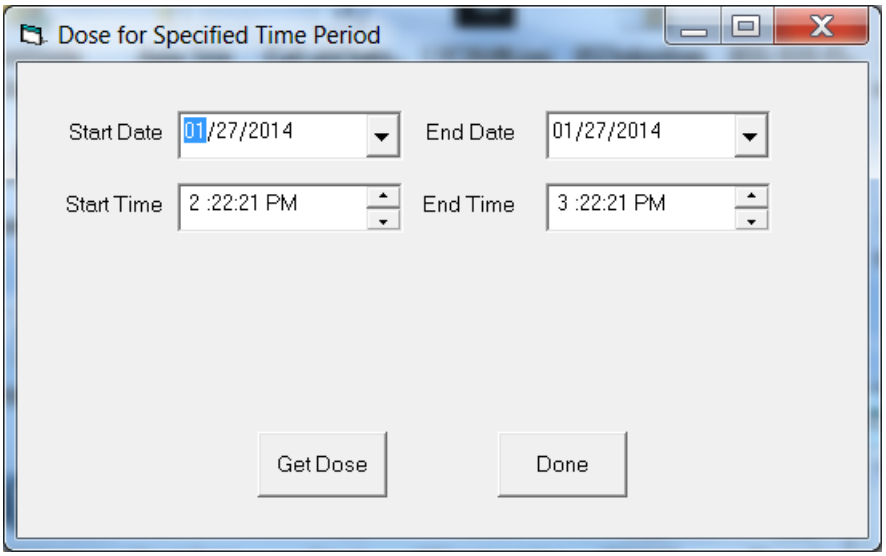
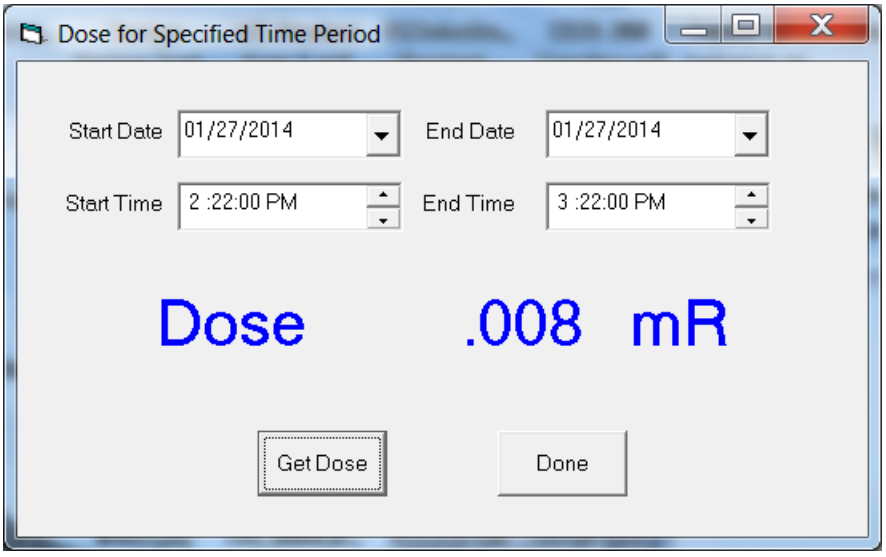
# Get Dose

It is sometimes desirable to know the total dose over a specified time period. The RSS-131 does not calculate this value, as it is dynamic. This option allows the user to enter start and end times.




Once these are entered and the user clicks on the Get Dose command button, the Configuration Utility uploads sensor data from the RSS-131 and then calculates the total dose over this period.




**NOTE:**

The RSS-131 supports mm/dd/yy, dd/mm/yy, and yy/mm/dd formats. The format specified in the RSS-131 must **exactly** match the PC format specified in the Regional Settings available



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from Control Panel on the PC. If these are not matched an incorrect (possibly invalid) date will be set in the RSS-131. Also, the RSS-131 does not support a '-' as the separator between month, day and year, so a '/' must be specified in the PC Regional Settings as the date separator.



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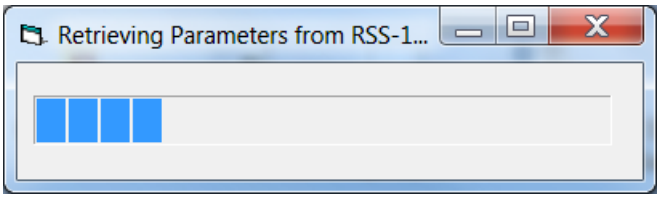
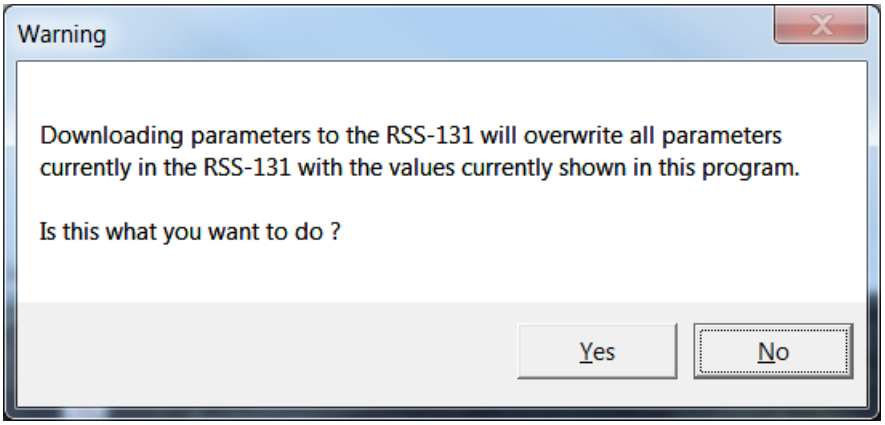
# Upload Configuration

This will cause all configuration parameters to be uploaded from the RSS-131 to the Configuration Utility. As parameters are retrieved from the RSS-131 they are displayed on the first pane of the status bar located on the lower portion of the main window. Parameters are uploaded from the RSS-131 automatically when the RSS131 Configuration Utility starts. After uploading the configuration all configuration options will show the existing values when screens are selected.




# Download Configuration

This option downloads all configuration parameters as they exist in the Configuration Utility to the RSS-131. This must be done with great care. If parameters are not uploaded from the RSS-131 prior to changing configuration parameters and then downloading parameters to the RSS-131 the unit may not function as expected. It is very likely radiation readings will not be correct if parameters are not uploaded prior to making changes since electrometer parameters are unique to each unit. For this reason the message box shown here will appear.


Warning
Downloading parameters to the RSS-131 will overwrite all parameters currently in the RSS-131 with the values currently shown in this program.
Is this what you want to do ?
Yes
No

If the user selects Yes all configuration parameters in the RSS-131 will be overwritten by the values in the Configuration Utility. If the user selects No there will be no changes made on the RSS-131.



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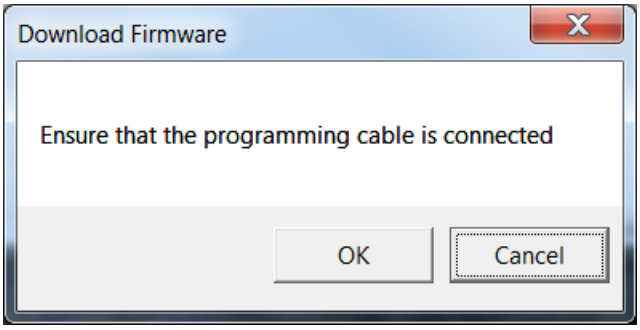
# Download Firmware to RSS-131

This option reprograms the firmware in the RSS-131. A programming cable (S131-PRGC-001) must be used. This cable must be connected to COM1 on the RSS-131. Once this cable is connected the RSS-131 enter reset and will no longer record data. You will be prompted to connect this cable before starting the download process as shown here.



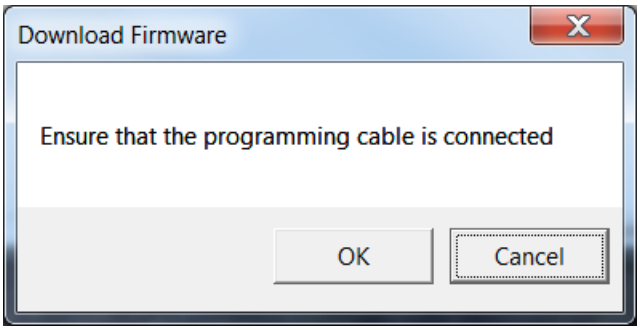

Next the HEX file containing the new firmware must be selected. This file is found on the CD that is supplied when units are purchased. The file is named HPIC.HEX for the 100 mR/h and 10 R/h units, but is named HPICER.HEX for the 100 R/hr (RSS-131ER) units.

Once the file is selected a progress bar will be displayed indicating what percentage of transfer is complete. Once completed the programming cable must be disconnected for the new firmware to execute.

Reprogramming the firmware resets all configuration parameters to their default values. These will need to be reloaded from the Reuter Stokes CD and downloaded to the RSS131. For complete details please refer to **Reprogram Firmware in** later in this document.

# Verify Firmware to RSS-131

This option verifies the code loaded in the RSS-131 matches the source file that is specified by the user. This also requires the special programming cable (S131-PRGC-001) be connected to COM1 on the RSS-131. The user will be prompted to ensure the cable is connected before being allowed to proceed.



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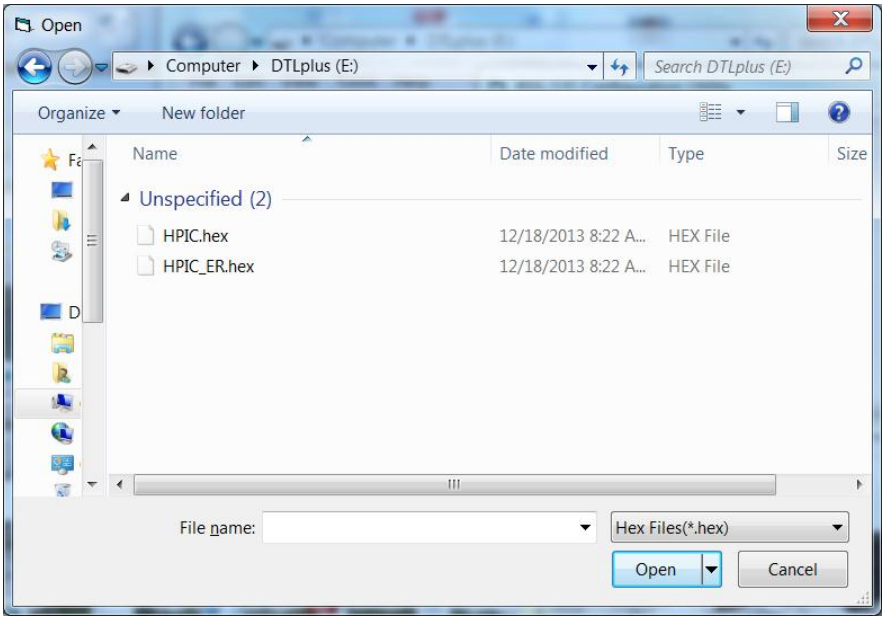
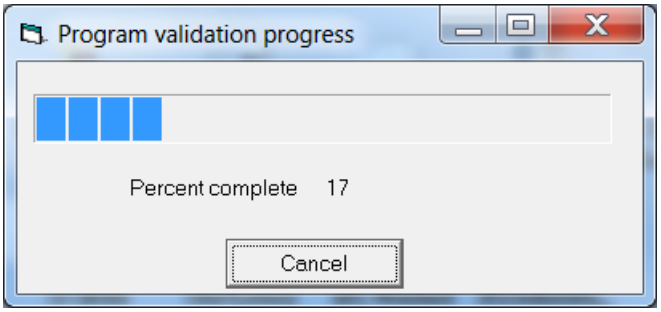
Once OK is selected the user will be prompted to enter the file containing the RSS-131 firmware using the Windows Common Dialog box. This file (HPIC.HEX) is found on the CD received from Reuter Stokes.




Once the file is selected the verification process will begin. As the file is verified progress will be reported to the user.




If the program loaded in the RSS-131 differs from the program selected by the user an error will be returned to the user.



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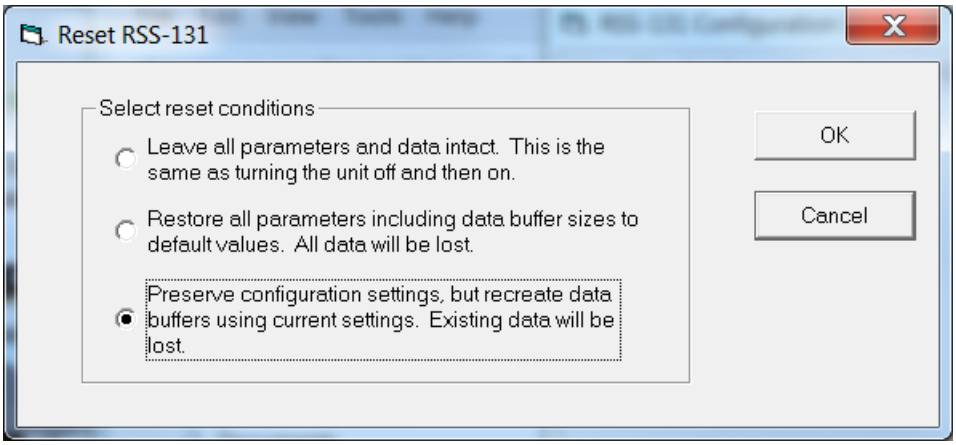
# Reset RSS-131

This window allows the user to reset the RSS-131. There are three different resets that may be accomplished. If the Cancel command button or the Windows X button is selected the dialog box will close with no action taken.


Reset RSS-131
Select reset conditions
Leave all parameters and data intact. This is the same as turning the unit off and then on.
Restore all parameters including data buffer sizes to default values. All data will be lost.
Preserve configuration settings, but recreate data buffers using current settings. Existing data will be lost.
OK
Cancel

A brief description of each possible reset condition is listed in **Figure 11**.

| Condition | Description |
|---|---|
| Leave all parameters and data intact | This simply restarts the RSS-131. All data and parameters are untouched. The only item affected is the amount of time reported since the unit was last restarted. |
| Restore all parameters to default values. All data will be lost. | Everything in the unit is reset. For proper operation the parameters provided in the configuration file by Reuter Stokes must be reloaded in the unit. |
| Preserve number of data points for each sensor and electrometer settings. Reset all other parameters to default values. | All parameters except data queue sizes and electrometer settings are set to default values. Any data in the queues will be deleted. This option is intended to allow the user to change data queue size and restart the unit. |

Figure 11: Reset Conditions



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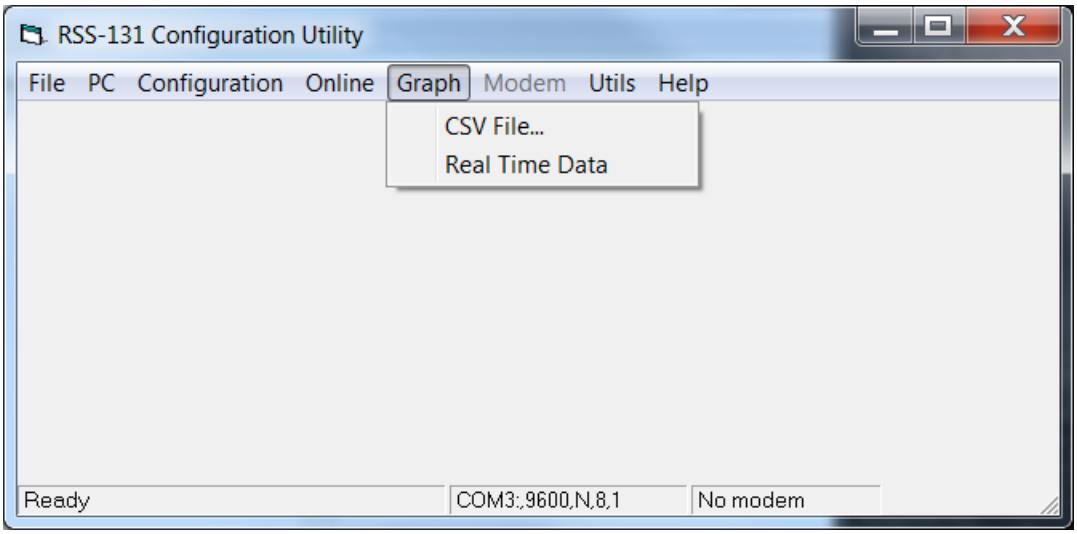
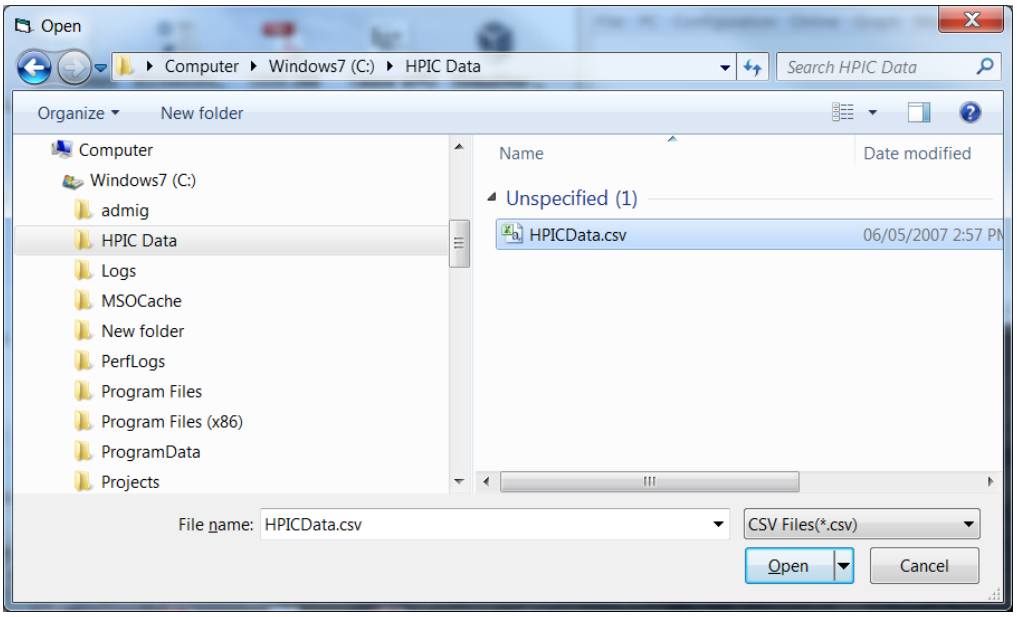
## Graph Menu

The Configuration Utility supports graphing of real-time data as well as CSV (Comma Separated Value) files. CSV files are generated when the Online...Upload Sensor Data option is executed. These files are also compatible with Microsoft Excel.




# CSV File

This option allows the user to graph data which was previously uploaded from the RSS-131 and saved to a file. The user is first prompted to specify which file is to be graphed. This file must contain date and time stamps in the first column with data in the second column.




Once the Open button is selected the graph will appear on the screen.



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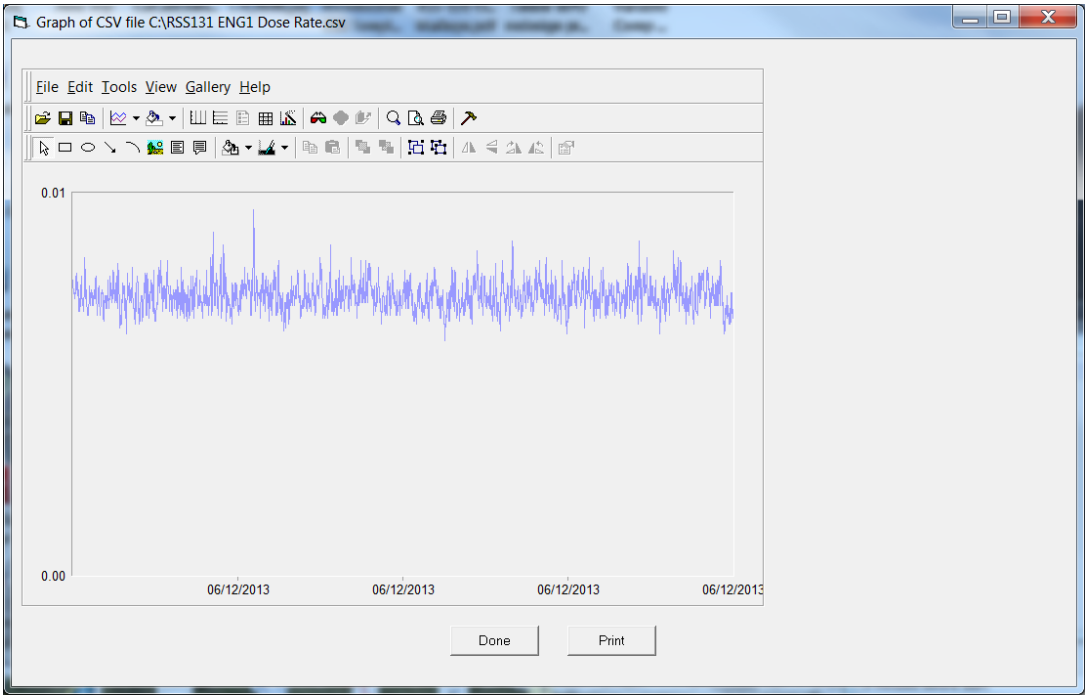


The graph can be printed by selecting Print. Many options can be changed using the toolbars above the graph.



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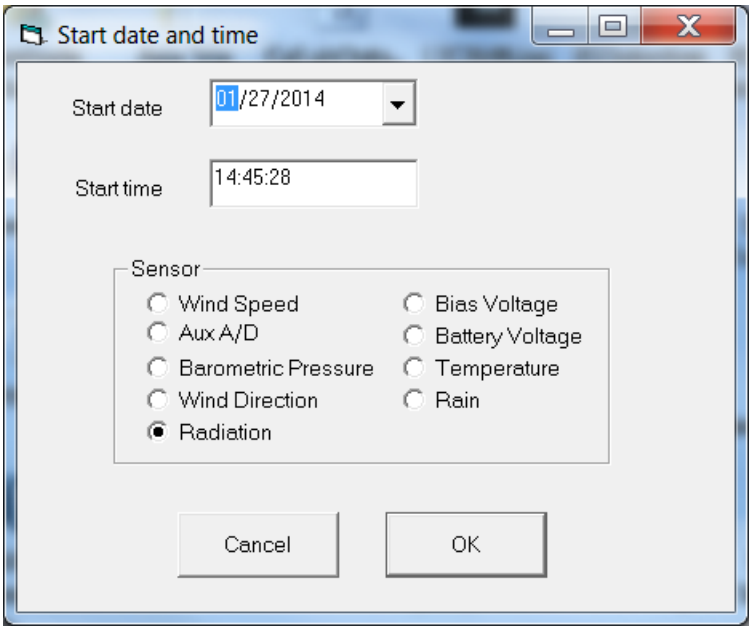
# Graph Real Time Data

This option allows the user to graph data real-time. As a data point is obtained in the RSS131 it is immediately added to the graph. The graph can contain up to 1,000 data points. If the graph already contains the maximum number of points and a new data value is received the oldest value is discarded and the newest one added.

The user must select which sensor is to be graphed as well as the time of the first data point. Once these are entered the Configuration Utility will retrieve historical data beginning at the Start Date and Start Time specified. Real-time data will be appended to this historical data.




**NOTE:**

The RSS-131 supports mm/dd/yy, dd/mm/yy, and yy/mm/dd formats. The format specified in the RSS-131 must **exactly** match the PC format specified in the Regional Settings available from Control Panel on the PC. If these are not matched an incorrect (possibly invalid) date will be set in the RSS-131. Also, the RSS-131 does not support a '-' as the separator between month, day and year, so a '/' must be specified in the PC Regional Settings as the date separator.



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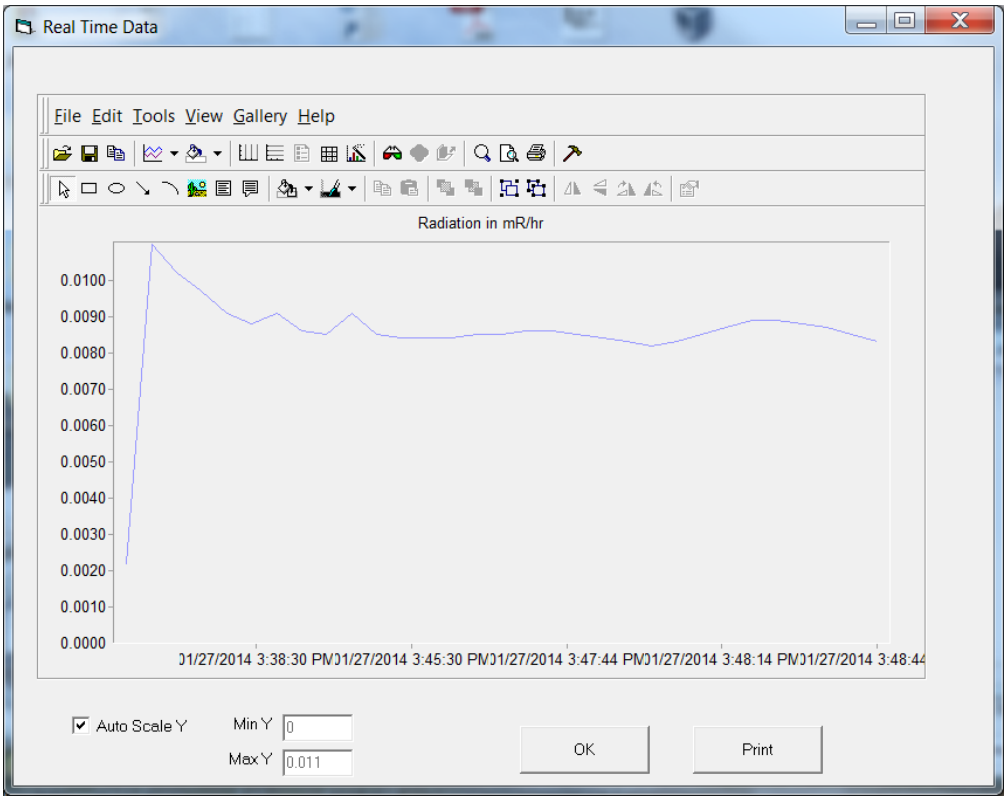
The graph looks very similar to the one shown when graphing CSV data. The graph title indicates what is being measured (radiation, battery, etc.) and units. Radiation may be displayed in uR/hr or nSv/hr. The label displayed depends on the selection made in the Config...General window. A sample graph is shown below.



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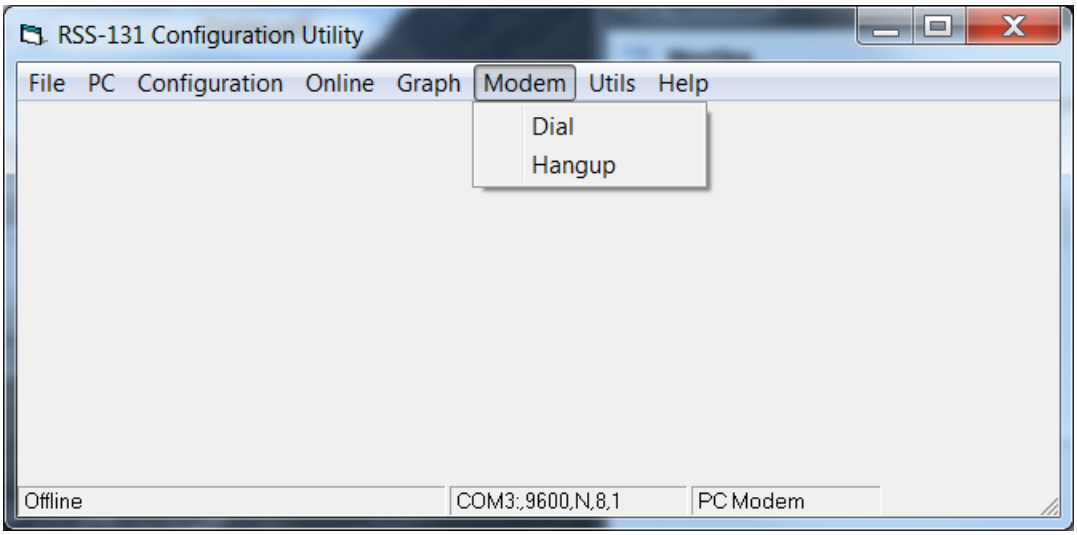
## Modem Menu

The modem menu is used to dial and hang up the modem. Modem initialization strings and phone numbers are set on the PC Serial Configuration menu.




# Dial

Selecting the Dial option causes the program to dial the modem using the phone number and COM port configured in the PC Serial Config screen. Once a connection is made all commands in the Online menu except firmware download and verification can be run as though a direct connection existed. Resetting the RSS-131 while connected via modem will work, but the modem connection will be lost when the RSS-131 resets.

If this option is selected when a call is already in progress no action will be taken.

# Hangup

This will cause the phone connection between the PC and RSS-131 to be dropped.



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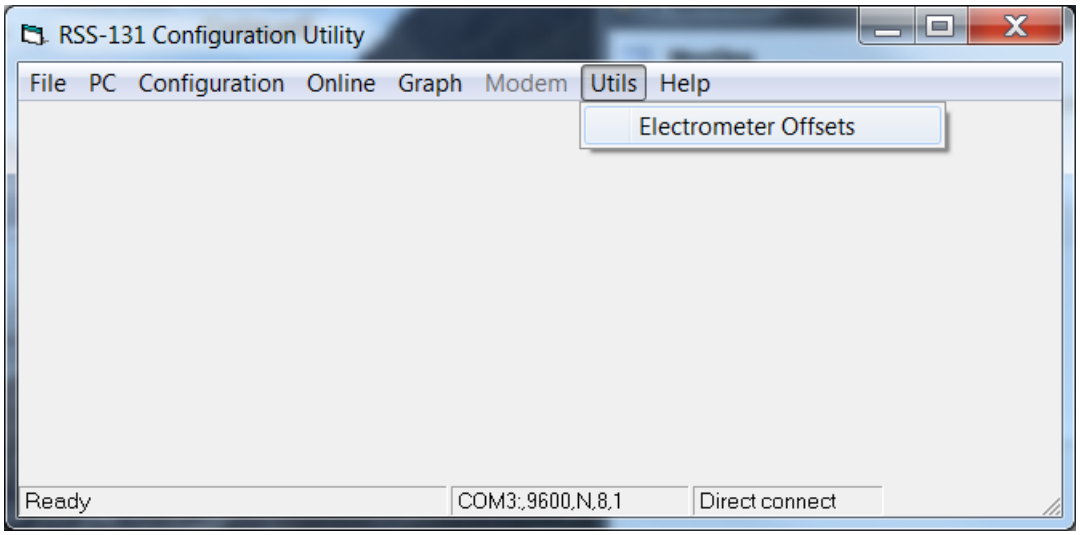
## Utils Menu

This utils menu provides a mechanism to calculate the electrometer range offsets for the entire system. These offsets are critical to correct range changes with varying dose rates. This is done at the factory but can also be done in the field if an electrometer is swapped out. **Do not perform this operation without factory approval. Should it be necessary to perform this operation in the field a separate work instruction will be sent to the user.**

This feature is requires that both the firmware and Configuration Utility be 6.0 or newer. Previous versions do not support this feature.



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# Configuration Caveats

The RSS-131 supports only the following date formats:

- mm/dd/yy
- dd/mm/yy
- yy/mm/dd

**The format specified in the RSS-131 must exactly match the PC format specified in the Regional Settings available from Control Panel on the PC.** If these are not identical an incorrect (possibly invalid) date will be sent from the PC to the RSS-131. Depending on which function is being used at the time, this may result in an invalid date being set in the RSS-131 (if trying to set date/time) or no date being sent from the RSS-131 to the PC (if uploading or graphing data).

The RSS-131 does not support a '-' as the separator between month, day and year, so a '/' must be specified in the PC Regional Settings as the date separator.

**Changing the date format deletes all data stored in the RSS-131, so data should be uploaded from the unit prior to changing date format.**

**Note**: The yy/mm/dd date format is requires firmware version 5.2 or later and configuration utility version 4.2 or later. The mm/dd/yy and dd/mm/yy date formats are supported in all versions of both firmware and configuration utility.



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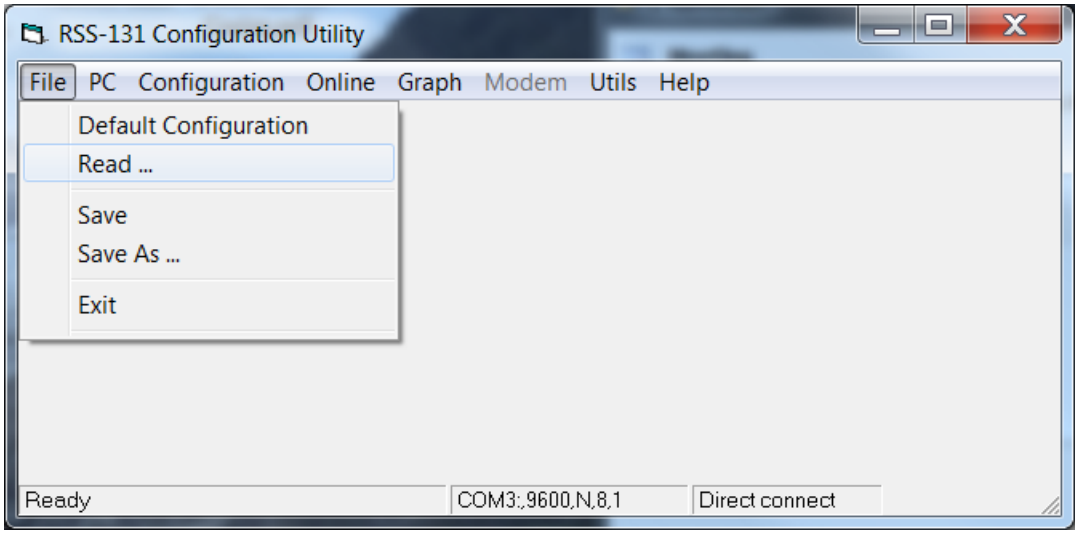
## Configuration Utility Examples

# Reload Parameters from Configuration File

The RSS-131 ships from the factory with a CD containing the latest firmware, Configuration Utility, and User Manual. In addition, the CD also contains a configuration file that is unique to the RSS-131 shipped with the CD. The parameters in this configuration file should be used only on the RSS-131 identified by the name of the configuration file (the name is the serial number of the RSS-131).

This example will show how to reload the RSS-131 with parameters from a previously saved configuration file. It assumes the configuration file is accessible on the PC, either on a disk drive or on the CD.

1. From the File menu, select Read



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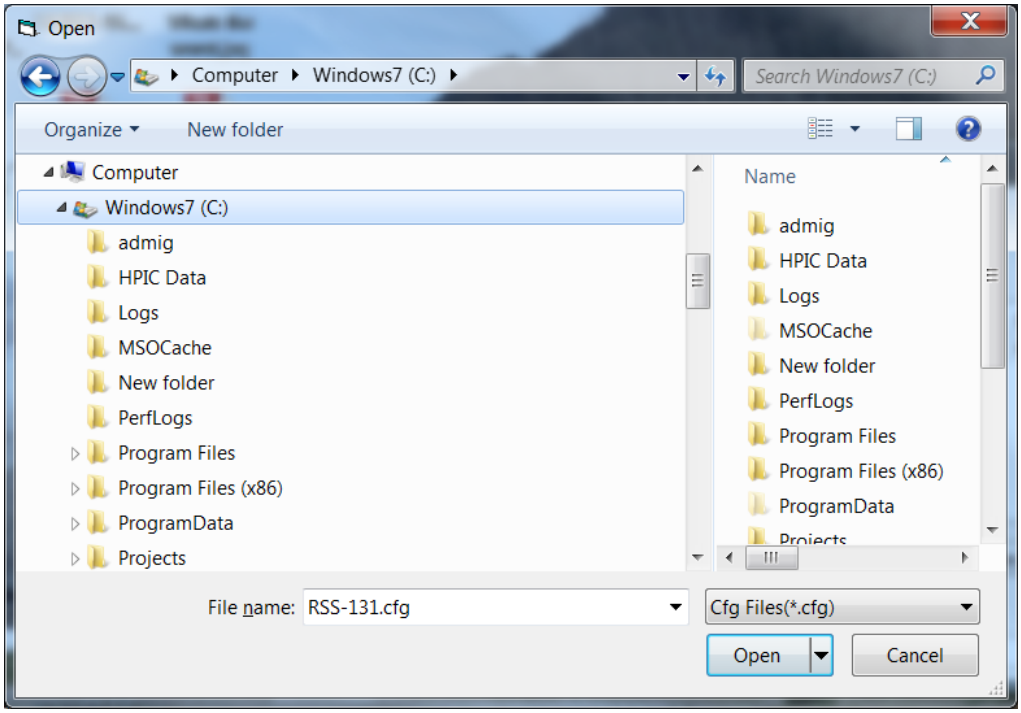
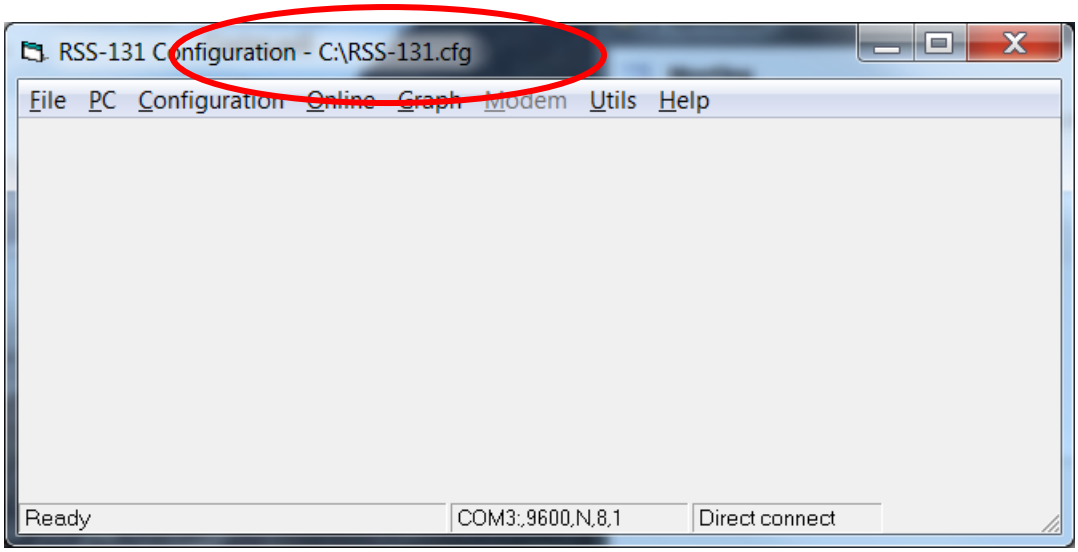
2. Select the configuration file from the dialog box that appears. In this example, the file is named RSS-131.cfg. Click the Open button once the file is selected.




3. The file will be read into the Configuration Utility. The main window will now show the file name in its menu bar as shown below.




4. Make any desired changes before downloading parameters to the RSS-131.



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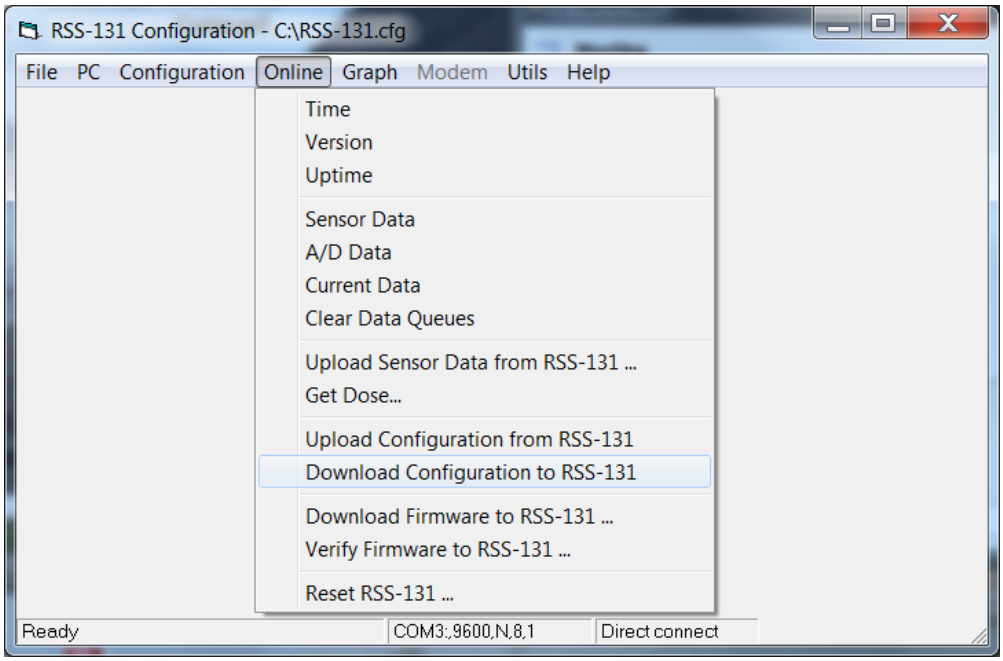
5. Download the configuration to the RSS-131. This will send all configuration parameters to the RSS-131.




6. The RSS-131 is now operating with the parameters read from the configuration file.



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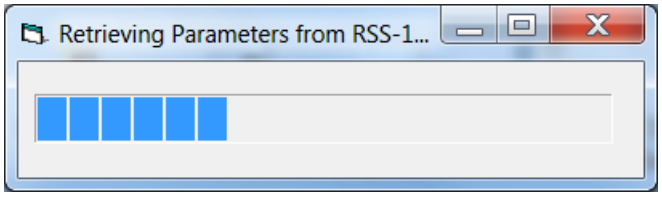
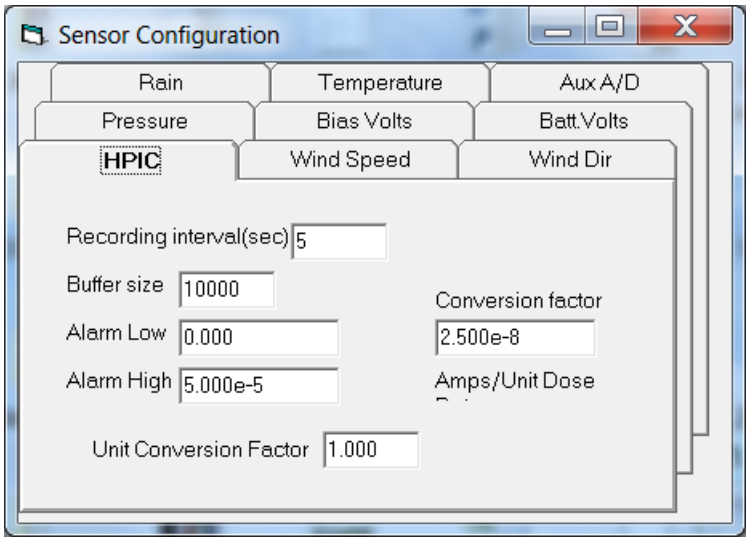
# Change Number of Radiation Data Points

This example will show how to set the number of radiation data points stored in the RSS-131 to 10,000. As always, care must be taken to ensure the total number of data points allocated for all sensors does not exceed the limit of 20,000.

1. Start the RSS-131 Configuration Utility. It will upload the current parameters from the RSS-131 into PC memory.




2. From the menu select Configuration...Sensors. Select the HPIC tab.



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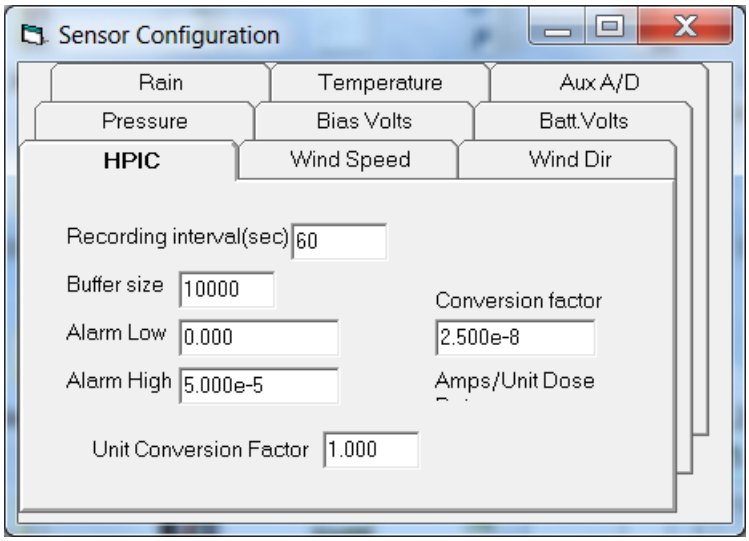
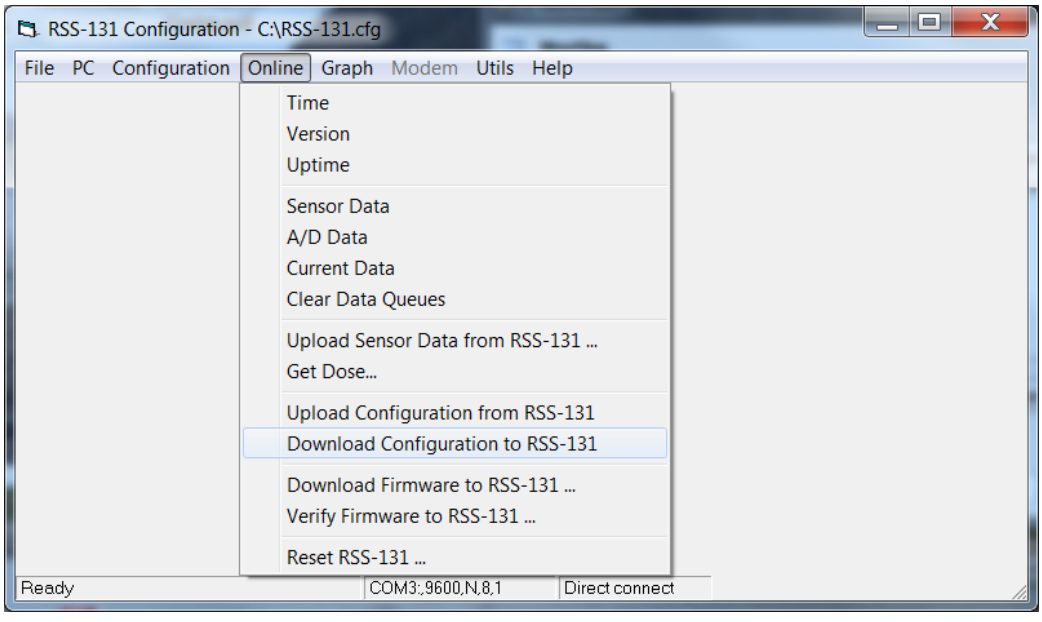
3. Set the buffer size to 10000




4. Close the window by clicking on the X in the upper right corner.
5. Download the configuration to the RSS-131. This will send all configuration parameters including the updated queue size to the RSS-131. The new queue size will not take effect until the unit is restarted.




6. From the menu select Online…Reset RSS-131. The program will display a dialog box displaying various reset modes. Select the third mode that will preserve data points and electrometer settings.



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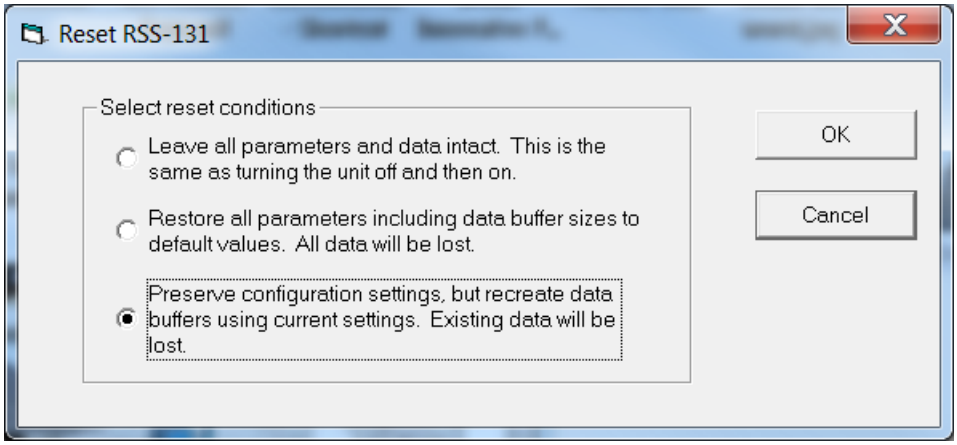
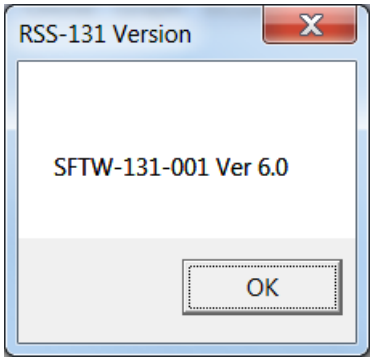

Reset RSS-131
Select reset conditions
Leave all parameters and data intact. This is the same as turning the unit off and then on.
Restore all parameters including data buffer sizes to default values. All data will be lost.
Preserve configuration settings, but recreate data buffers using current settings. Existing data will be lost.
OK
Cancel

7. The RSS-131 will reset and after a few seconds display the current version string.




8. The RSS-131 is now running with the new queue size.



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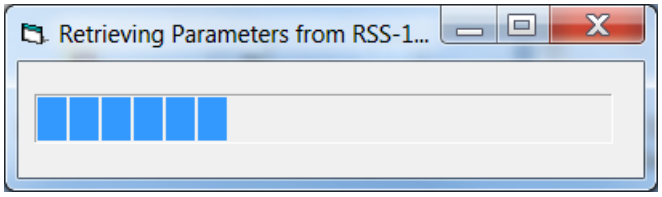
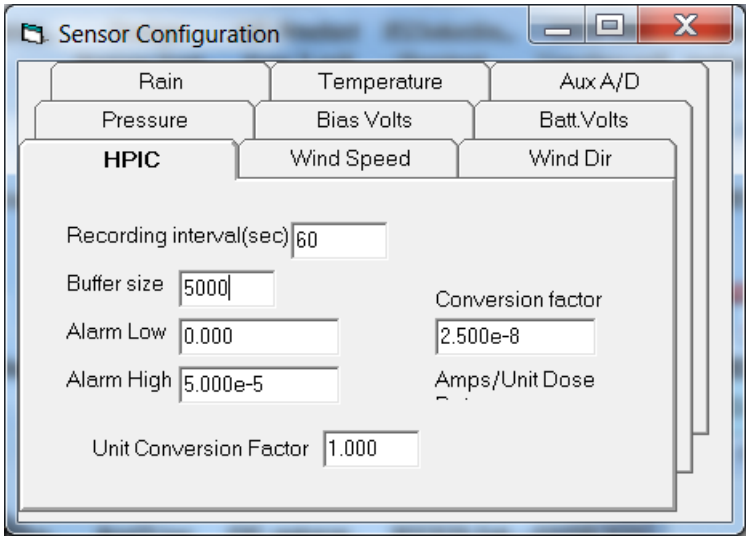
# Change the Radiation Recording Interval

Changing the recording interval for a sensor is similar to changing the number of data points. Unlike changing the queue size a new recording interval take effect immediately when it is downloaded without requiring a reset. This example will change the radiation recording interval from its default of 60 seconds to 5 minutes.

1. Start the RSS-131 Configuration Utility. It will upload the current parameters from the RSS-131 into PC memory.




2. From the menu select Configuration...Sensors. Select the HPIC tab.



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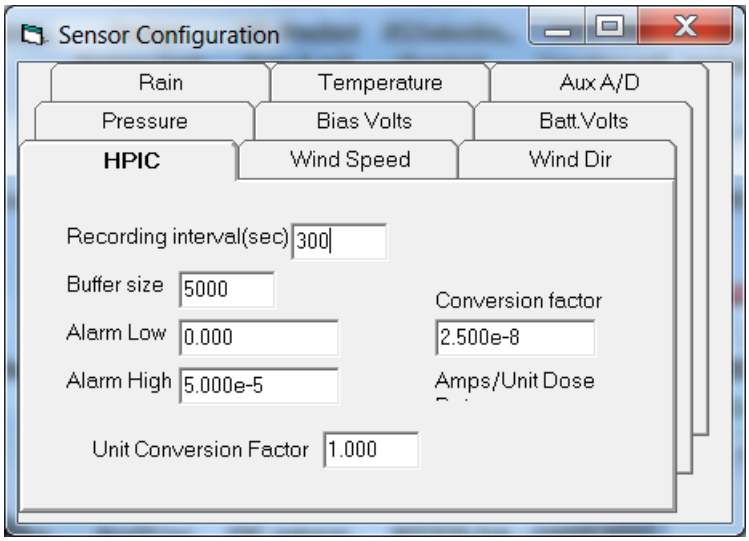
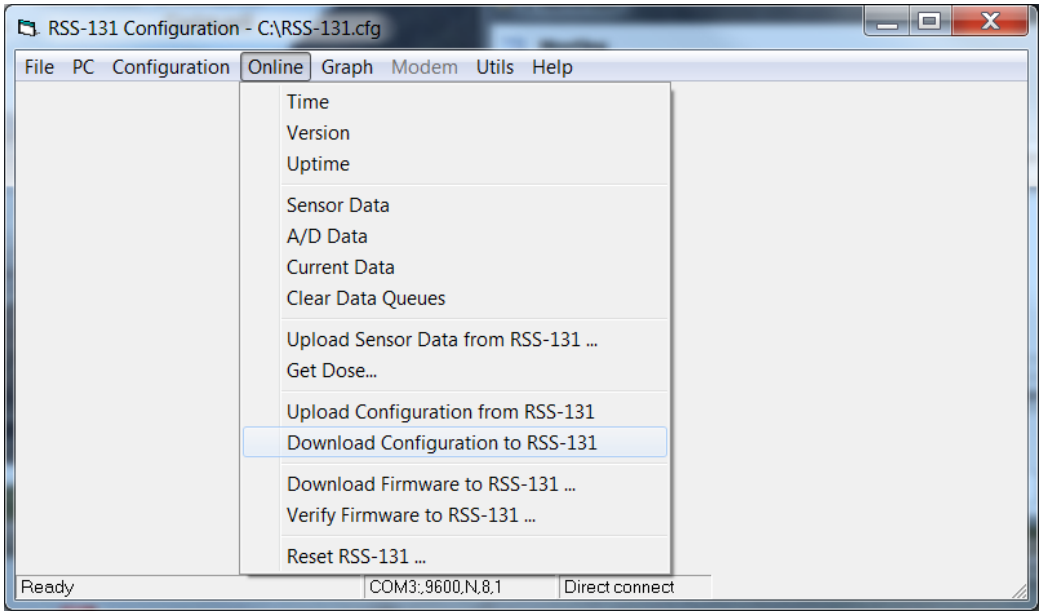
3. Set the recording interval to 300 seconds (5 minutes).




4. Close the window by clicking on the X in the upper right corner.
5. Download the configuration to the RSS-131. This will send all configuration parameters including the updated recording interval to the RSS-131.




6. The new recording interval will take effect immediately after the next radiation value is recorded.



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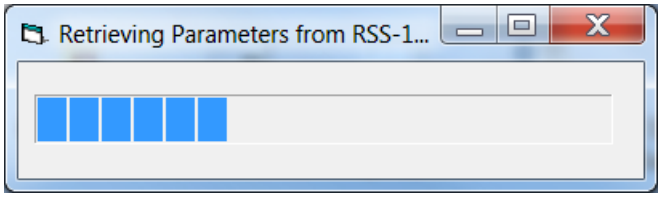
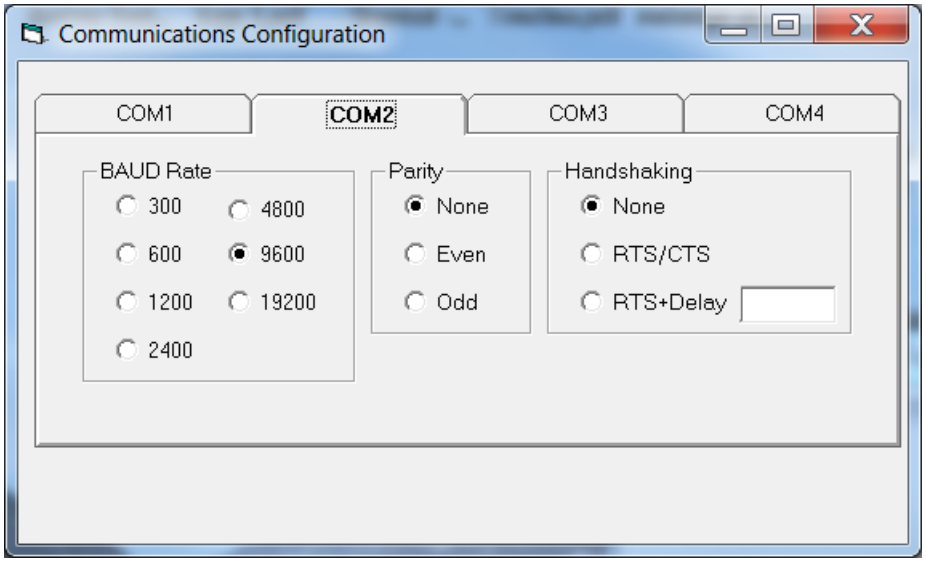
# Changing Serial Settings

It may be desirable to use serial settings other than the default values of 9600 baud, 8 data bits, 1 stop bit and no parity. This example shows how to change these settings. Once the sequence shown is complete both the PC and RSS-131 will be operating on the new settings.

1. Start the RSS-131 Configuration Utility. It will upload the current parameters from the RSS-131 into PC memory. If the configuration utility is already running but parameters were not uploaded when the program started you should manually do this now by selecting Online...Upload Configuration from RSS131. If parameters have not been uploaded from the unit prior to changing settings incorrect values may be sent to the RSS-131.




2. From the menu select Configuration...Communications. Select the COM port which is to be modified.
3. Select the desired baud rate, parity and handshaking if supported on the specific COM port.



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4. Close the window by clicking on the X in the upper right corner
5. Download the configuration to the RSS-131. This will send all configuration parameters including the new serial parameters to the RSS-131. The new serial settings will take effect immediately on both the RSS-131 and PC when the serial commands for that particular COM port are sent from the PC to the RSS-131. Serial parameters sent prior to the updated serial settings will be transmitted at the original settings. All communications after the updated serial settings will occur using the new values.



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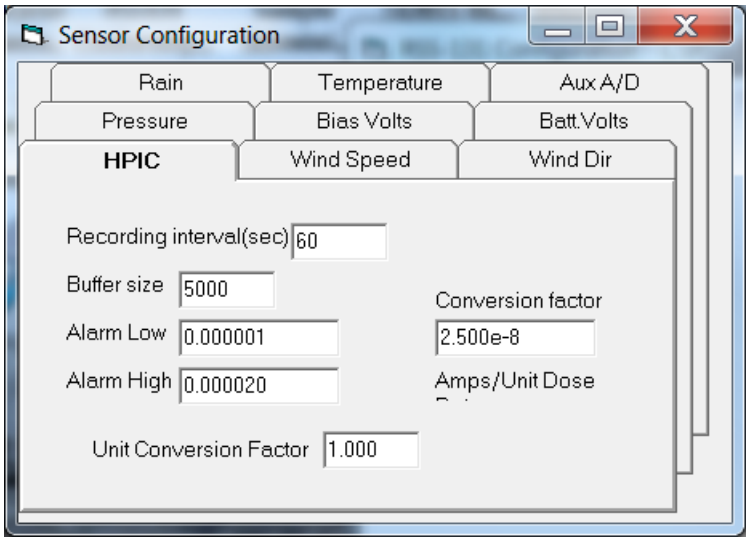
# Changing Alarm Settings

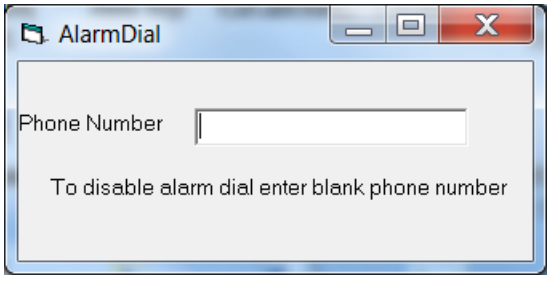
If it is desired to have the RSS-131 call a remote computer when a sensor obtains a reading which is above or below a certain threshold the RSS-131 must be configured to know both the threshold values and what phone number to call. This example will demonstrate how this is done. It assumes the configuration utility is already running and parameters have already been uploaded from the RSS-131 so those in the PC memory match those in the RSS-131.

6. From the menu select Configuration…Sensors and select the desired sensor from the tabs at the top of the dialog box.




7. Enter the low and high levels at which alarms are to be generated. The values entered should take into account any unit conversion factor which is specified. For example, radiation is recorded internally as mR/hr. However, if mSv/hr is desired there would be a unit conversion factor of about 8.7 specified in the Unit Conversion Factor text box. In such a case, the alarm low and alarm high values should be multiplied by 8.7. To disable high and low level alarms for a given sensor specify either the low or high level to be 0.

8. Once the alarm levels are specified the phone number which will be called if an alarm is detected must also be specified. This is done by selecting Configuration…Alarm Dial from the menu. Enter the phone number in this window. To disable calling a computer when an alarm is generated simply delete the number in the text box.




9. Once the above settings are complete they must be downloaded to the RSS-131 before they take effect. This is done by selecting Online…Download Configuration to RSS-131 from the menu. Once this is complete the unit will begin monitoring alarm levels.



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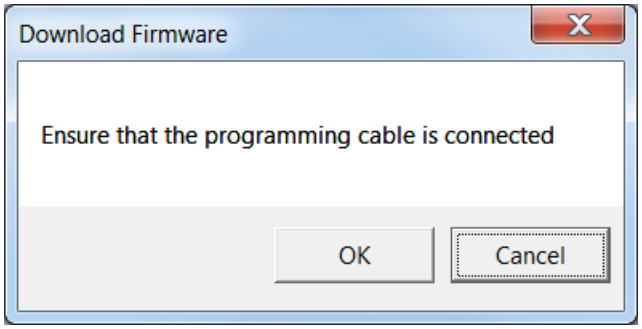
# Reprogram Firmware in RSS-131

This example will detail the steps required to reprogram the firmware in the RSS-131. **Prior to reprogramming the RSS-131 make sure you have a current copy of the configuration file for the unit as these parameters will be required to restore the unit to its operating condition**. If necessary, a new configuration file can be created by uploading parameters from the RSS-131 and saving them to a file before programming the unit. This step is not detailed in this example.

1. The programming cable (PRGC-131-001) must first be connected between the PC and RSS-131. When this is connected to the RSS-131 it will stop recording data and enter bootstrap mode while it waits for firmware to be downloaded.
2. From the menu select Online…Download Firmware to RSS-131. This will cause a message box to appear reminding the user to connect the programming cable




3. To abort programming click the Cancel command button. To proceed with reprogramming the unit select the OK command button.
4. A dialog box will appear asking which file is to be programmed into the RSS-131. Point to the location of the firmware file that is to be used and click the Open command button. The files are named
    - HPIC.HEX for S131-11x-10xxxx and S131-11x-20xxxx units
    - HPICER.HEX for S131-11x-ERxxxx units



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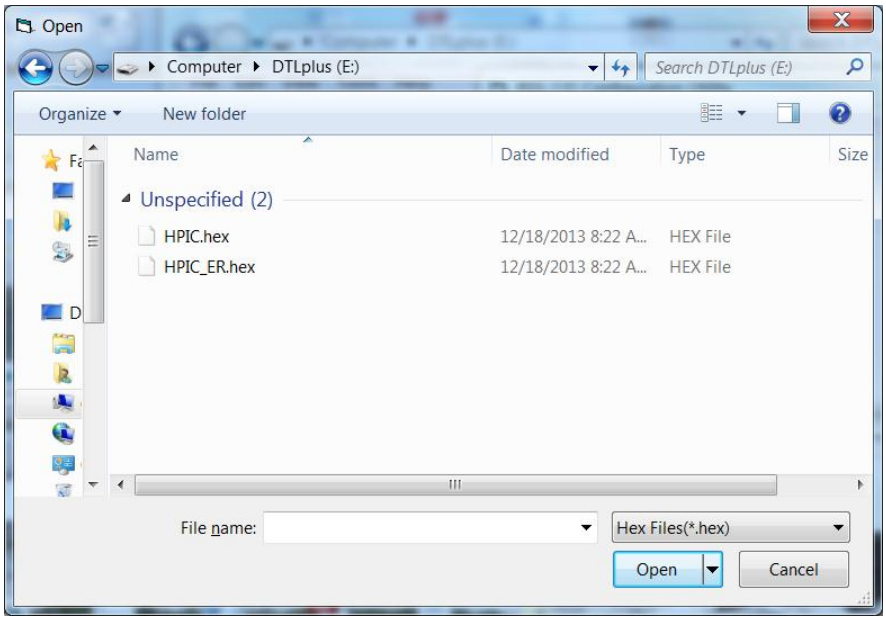




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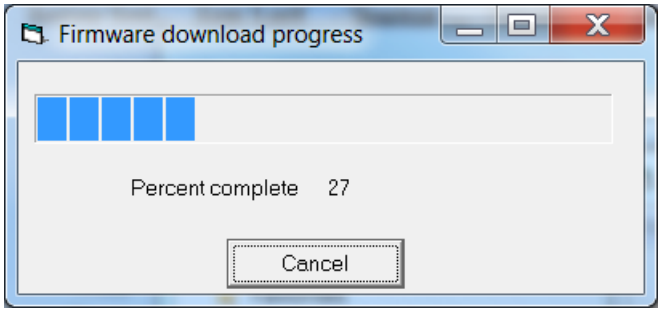
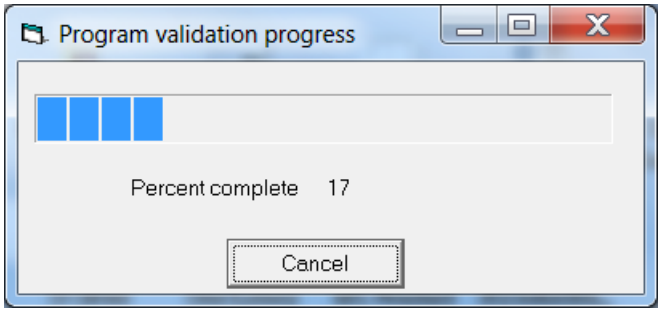
5. The Configuration Utility will immediately begin reprogramming the RSS-131. A message box will appear indicating the current status of the programming operation.




6. Once the firmware download is 100% complete the Configuration Utility will verify the program that was downloaded matches the original file.




7. Once the validation process is complete, remove the programming cable from the RSS-131. When the cable is removed the RSS-131 will reset itself and begin executing the firmware that was just programmed. At this point all parameters have been reset to default values. The user must now reload the parameters that are specific to the unit just programmed.



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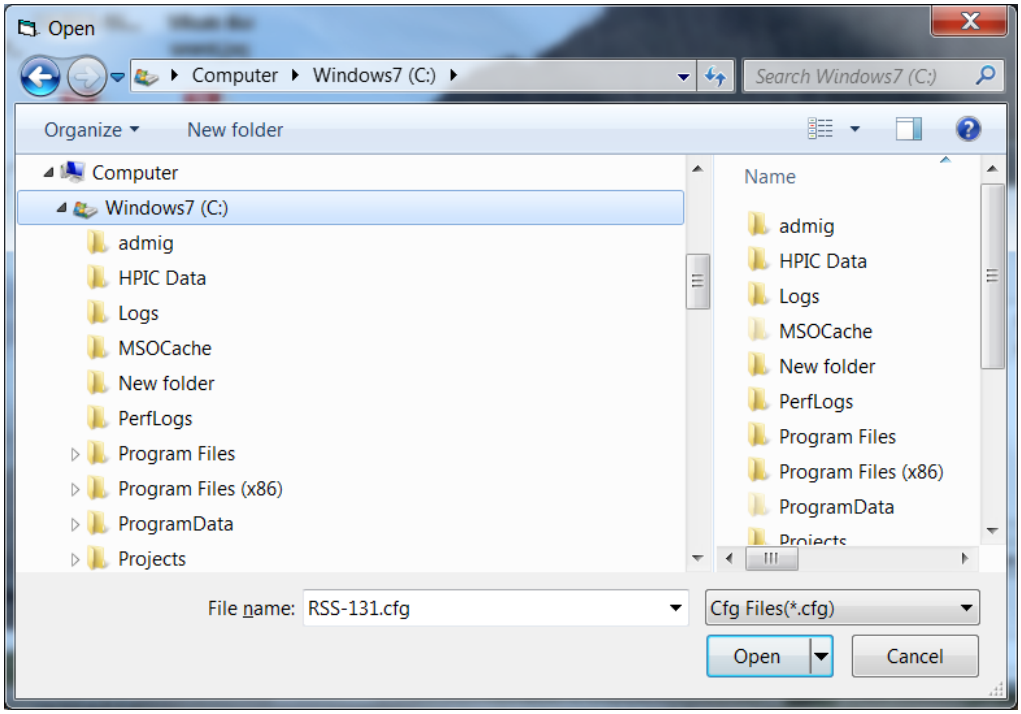
8. Read the configuration file that contains parameters for this unit by selecting File…Read from the menu.




9. Select the configuration file and click on the Open command button. This will read the parameters into PC memory.
10. The parameters must now be downloaded to the RSS-131. This is done by selecting Online…Download Configuration to RSS-131.
11. The RSS-131 is now running with all parameters correctly set.



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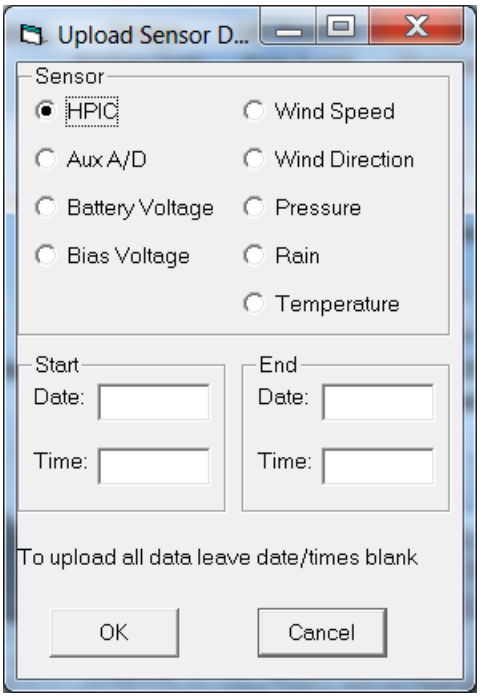
# Uploading Sensor Data from RSS131 to the PC

This example will detail the steps necessary to upload historical data for one of the RSS131 sensors (radiation, battery, etc.) to the PC. The Configuration Utility does not support uploading data for all sensors at once; uploading data for more than one sensor requires multiple uploads. Once uploaded to the PC this data will be stored in a Comma Separated Value (CSV) file that may be read directly into Microsoft Excel for graphing or other analysis.

1. From the menu select Online…Upload Sensor Data from RSS131.
2. The Configuration Utility will verify communications with the RSS131. Once communications are successful the following will appear.




3. Select the desired sensor in the upper portion of the screen. In this example radiation data will be uploaded from the RSS131. To upload all data for the specified sensor leave the Start and End fields blank. To upload sensor data only for a particular time frame enter both Start and End values. Click OK once all data is selected correctly.



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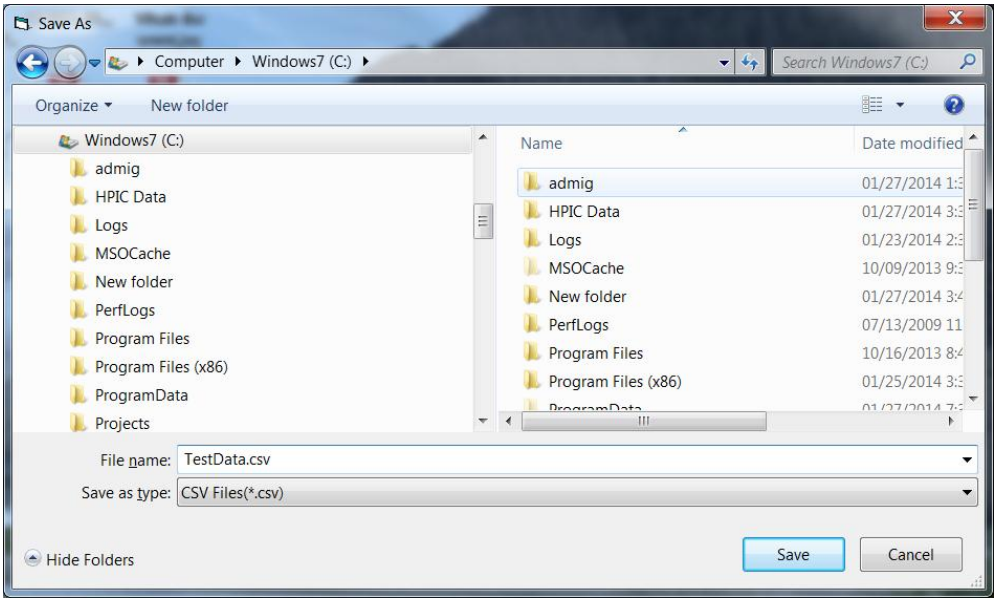
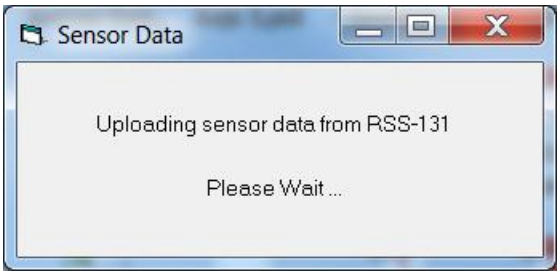
4. Once OK is clicked a dialog box appears prompting for a file name. The Configuration Utility will store the data in a CSV file whose name is specified by the user.




5. After entering a file name select Open. Data will now be uploaded from the RSS to the Configuration Utility. A message will appear to let the user know what is happening.



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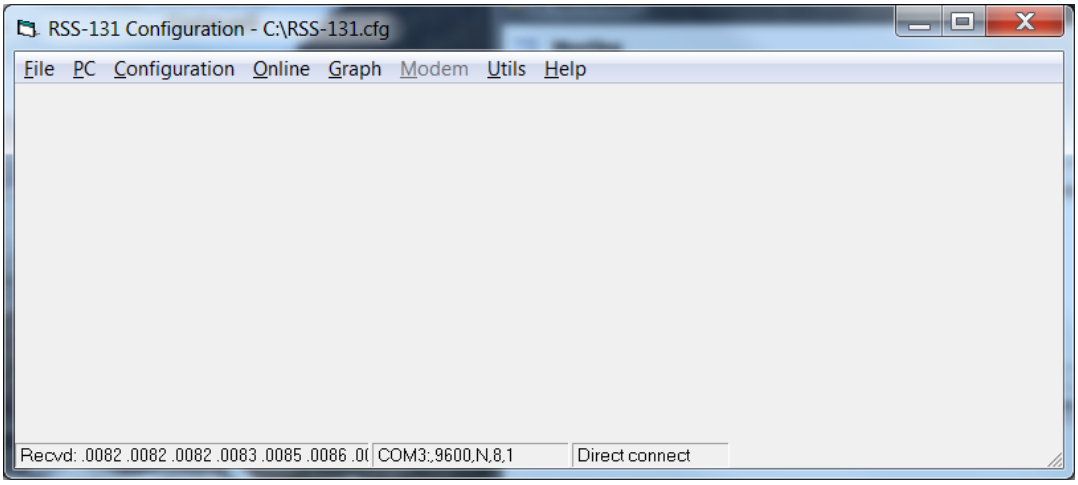
While data is uploading from the RSS131 individual values are displayed on the status bar located at the bottom left of the main window. This data changes with each line of data received from the RSS131.


RSS-131 Configuration - C:\RSS-131.cfg
File PC Configuration Online Graph Modem Utils Help
Recvd: .0082 .0082 .0082 .0083 .0085 .0086 .0(
COM3:,9600,N,8,1
Direct connect

6. Once all sensor data has been retrieved the CSV file may be viewed directly by Microsoft Excel or other programs which support CSV files.
7. This process must be repeated for each sensor.
8. The data will appear in the CSV file as shown here. The first column is the time stamp and the second column is the data value.

8/24/2001 10:36 0.0073
8/24/2001 10:37 0.0072
8/24/2001 10:38 0.0076
8/24/2001 10:39 0.0074
8/24/2001 10:40 0.0074
8/24/2001 10:41 0.0073
8/24/2001 10:42 0.0071
8/24/2001 10:43 0.0072
8/24/2001 10:44 0.0069
8/24/2001 10:45 0.0071
8/24/2001 10:46 0.0072
8/24/2001 10:47 0.0073
8/24/2001 10:48 0.007
8/24/2001 10:49 0.0072
8/24/2001 10:50 0.0072
8/24/2001 10:51 0.0074
8/24/2001 10:52 0.0071
8/24/2001 10:53 0.0073



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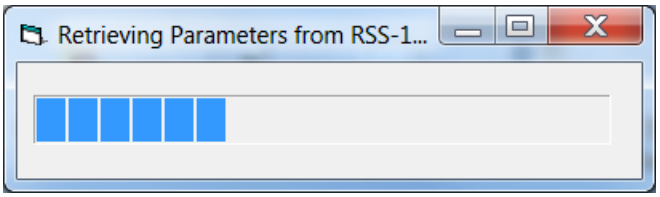
# Saving Current Configuration to Disk

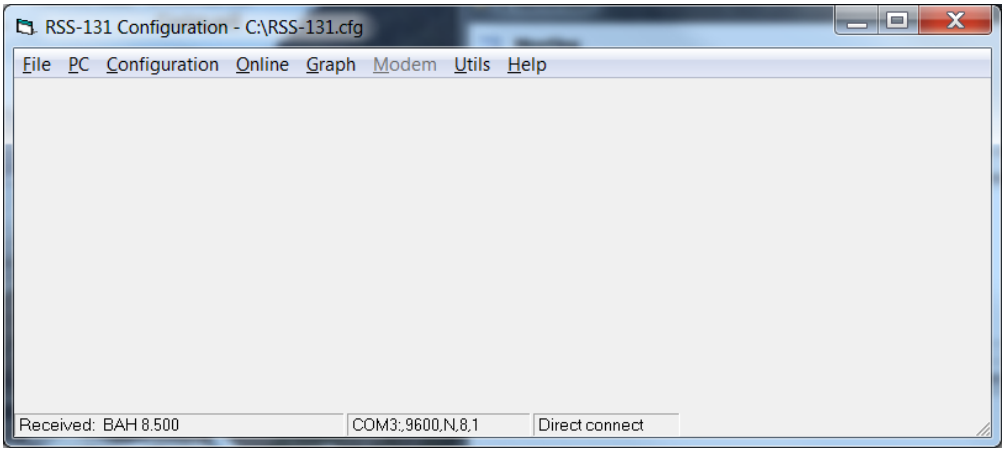
This example shows how to store the current configuration as it exists in the RSS-131 to disk on the PC. This is a two step process. The configuration information must first be uploaded from the RSS131. This configuration information must then be saved to disk. The file saved to disk is ASCII format and can be viewed with any editor such as WordPad, NotePad or Microsoft Word.

## Step One – Upload Configuration Information from RSS131

1. From the main window select Online…Upload Configuration from RSS131.
2. The Configuration Utility will verify communications with the RSS131. Once communications are successful the following will appear.




3. While parameters are being retrieved from the RSS-131 the they are displayed on the status bar located on the bottom left of the main window.




4. The parameters are now ready to be saved to disk. Click OK to close the Upload Complete message box.

## Step Two – Save Configuration to Disk

5. Select File…Save As from the main menu.
6. A dialog box will appear prompting the user for a file name. This file will have a .CFG extension indicating this is a configuration file. It is recommended the file name contain the RSS131 serial number for easy identification. Enter a unique file name and select Save.



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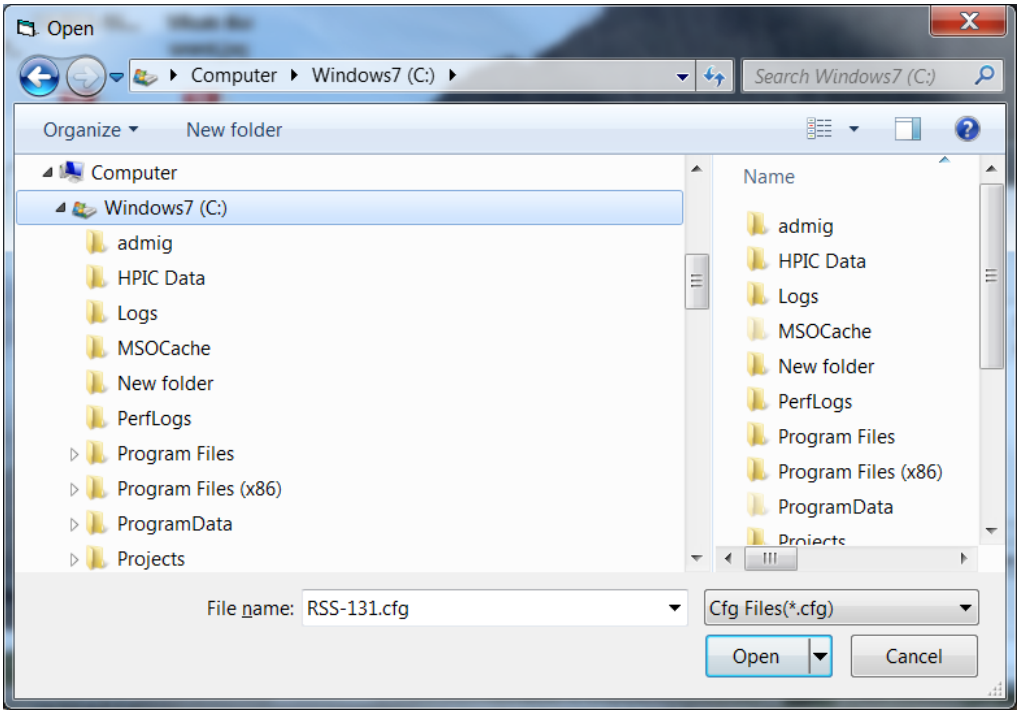


7. The configuration file will now be saved to the location specified.



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# Configuring the External Serial Display

This example shows how to configure the external display. It assumes the display is connected to the RSS-131 by the correct serial cable (S131-232-003).

1. Make sure the switches on the display are set as follows. To view the switches the small metal cover on the back of the display must be removed.

| Switch | Position |
|---|---|
| 1 | Off |
| 2 | Off |
| 3 | Off |
| 4 | Off |
| 5 | On |
| 6 | On |
| 7 | Off |
| 8 | Off |
| 9 | On |
| 10 | On |

2. Power on the display. A message should scroll repeatedly on the display. It should read **9600 BAUD, 8 DATA, NO PARITY, 1 STOP, 00 ADDRESS**
3. From the main menu select Configuration…General. The screen shown below should appear.



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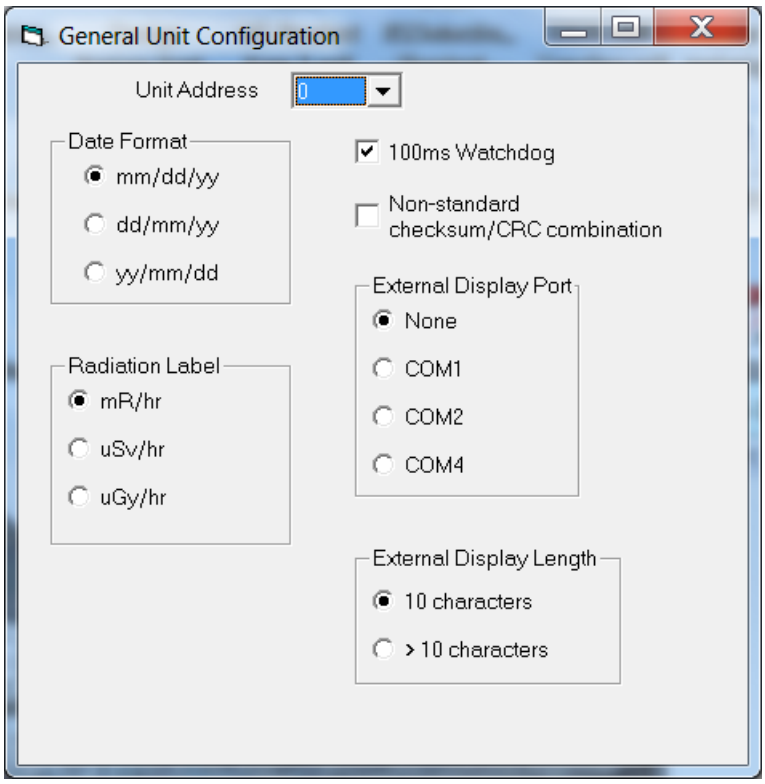


4. Select the Radiation Label that is to be displayed on the external display.
5. Select the External Display Port that will be used to communicate with the display.
6. Download the changed parameters to the unit by selecting Online…Download Configuration to RSS-131.
7. As data points are recorded in the RSS-131 they should now be shown on the display as well.



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Appendices

## Program Loading

Program loading requires a custom cable (S131-PRGC-001) that must be connected to COM1. This cable ties the /PPROG signal on the micro controller to ground. The pinout for this cable can be found in the Interconnecting Cable appendix at the end of this manual. **When this cable is connected the RSS-131 is held in reset and is not gathering data.**

After the unit is programmed and the programming cable removed the RSS-131 will immediately reset. At this point default parameter values will be used to ensure a known state of the board. These parameters can be changed at a later time using one of the serial ports and a n ASCII terminal or a PC with the Configuration Utility (RSS131Config.exe). A complete list of parameters is included in this manual. The configuration utility is normally used to load the firmware but it may also be done "manually" by using a terminal program. This procedure is described below.

# Manual Program Loading

To program the board manually follow these steps. Any serial terminal program may be used, but the following steps assume Windows Terminal is being used.

- Connect the programming cable between the PC and board
- Invoke Windows Terminal and configure it for 19200,N,8,1 with no handshake, no local echo, and no translation of CR to CR/LF.
- Hit Enter on the PC. The micro-controller should echo its version string to the display. If not, verify you have the correct cable, correct COM port and settings, check connections and repeat.
- Type 'L' and then hit Enter on the PC. The cursor should move to the next line. No new text will be added to the display at this time. The micro-controller is now waiting for the download.
- In the Terminal program select Transfers … Send Text File from the menu. Specify the Intel Hex file that contains the board program (hpic.hex or hpicer.hex). Click Send and the program will be transferred. A progress bar on the bottom of the screen will indicate download status. If local echo is enabled the contents of the hex file will be displayed on the screen. Wait until the file is 100% complete. This is indicated by the progress bar going blank and two '>' characters being displayed, one per line.
- Enter the string "W MSL 0"
- Enter the string F 0 0 10. This will overwrite the signature string and force all parameters to return to their default values.
- Reconfigure the Windows Terminal program for 9600,N,8,1 so it matches the default parameters in the 131.
- Connect the normal serial cable from the PC to the RSS-131.
- Remove the programming cable. This will cause the micro-controller to go through a reset and the program will execute



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normally. The 131 will not execute code until the programming cable is removed.



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## Diagnostic Commands

There are a number of serial commands that are ***only used for internal GE diagnostic purposes***. They are not intended for customer use. These commands are documented only for informational purposes.

| Command | Function |
|---|---|
| B | Display A/D data |
| J | Display queue data as it is written for one input |
| Y | Reboot device |

**Table 6: Diagnostic Serial Commands**

# Display Raw A/D Data (#B)

This command will display raw A/D data for all channels and the electrometer range. One line will be sent every time new data is available, which occurs once per second. It will continue to do this until any character is received at the COM port. The A/D values are the raw values the micro controller reads at its input port connected to the Analog to Digital converter. A table of the A/D inputs and their functions are described in the following table. The wind speed, electrometer ranges and rain gauge are not actually A/D inputs, but are included for completeness of sensor data.

| Column | Sensor |
|---|---|
| 0 | Wind speed |
| 1 | Unused |
| 2 | Barometric pressure |
| 3 | Wind direction |
| 4 | HPIC (radiation) |
| 5 | High voltage bias |
| 6 | Battery |
| 7 | Temperature |
| 8 | Electrometer range |
| 9 | Rain gauge |

COMMAND

**#B *yy b***<CR>

***yy*** = the HPIC ID. A one byte value that ranges from '0' to 'Z' (ASCII) excluding '@'.

RESPONSE



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The data read from the A/D converter will be returned. Channels are displayed in ascending order from left to right, with channel 0 displayed first followed by channel 1, channel 2 and so on. The current electrometer range is displayed in the 9th column, while the A/D resistor scaling is in the 10th column. Rain volume is located in the last column.

Electrometer ranges (column 9) are defined as follows:

0 – low range normal operation

1 – middle range normal operation

2 – high range normal operation

A/D resistor scaling (column 10) is defined as follows:

0 – scaling not active

1 – scaling active

A typical display will look as follows:

**<CR>**

**.0000 .0000 .0000 .0000 95.00 3917. 3355. 777.0 0 0 .0000**

**.0000 .0000 .0000 .0000 110.0 3930. 3314. 777.0 0 0 .0000**

**.0000 .0000 .0000 .0000 106.0 3921. 3247. 777.0 0 0 .0000**

EXAMPLES:

**#B 0**<CR> to read all A/D channels continuously



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# Display queue data as it is written (#J)

This command will display each value as it is written to the queue for one sensor. Values will continue to be displayed until any key is hit on the terminal that is displaying the data. When a key is hit to stop displaying data no response will be echoed to the display.

COMMAND

| | |
|---|---|
| ***#J yy p n***<CR> | if software version < 1.5 |
| ***#J yy n***<CR> | if software version >= 1.5 |

yy = the HPIC ID. A one byte value that ranges from '0' to 'Z' (ASCII) excluding '@'.

***p*** = which COM port is to receive the data (1, 2 or 3). **This is only used in versions less than 1.5.**

***n*** = which analog input is to be monitored.

'0' = Wind speed

'1' = Auxiliary Input

'2' = Barometric Pressure

'3' = Wind direction

'4' = HPIC Output

'5' = 300V

'6' = Battery

'7' = Temperature

RESPONSE

The board will echo **"OK"** to the port. From then on the point value will be displayed each time it is written to the queue. If a sensor is configured with an interval of 5 minutes there will be 5 minutes between displayed values.

**<CR>**

**OK**

**.0065**

EXAMPLES:

| | |
|---|---|
| **#J 0 1 4**<CR> | to display radiation values on COM1 as they are written to the queue with software version < 1.5 |
| **#J 0 2 7**<CR> | to display temperature values on COM2 as they are written to the queue with software version < 1.5 |



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| | |
|---|---|
| **#J 0 4**<CR> | to display radiation values on the serial port which receives the command as they are written to the queue with software version >= 1.5 |
| **#J 0 7**<CR> | to display temperature values on the serial port which receives the command as they are written to the queue with software version >= 1.5 |



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# Reset System (#Y)

This command will reboot the data board. Data may be cleared and parameters reset to their default values as well. Care must be taken since if default parameters are restored using either the '1' or '2' options all COM parameters including baud rates will be reset. This could cause radios and other serial devices to stop working if they are not running at the default baud rates!

Rebooting the board using any of these options will cause any connection to the board through the modem to be disconnected.

Beginning with RSS-131 firmware (SFTW-131-001) version 2.0 the reset string was made larger to prevent noise on the line from accidentally causing resets. This longer string consists of " 12345" after the original string.

COMMAND

#Y yy v<CR>

***yy*** = the HPIC ID. A one byte value that ranges from '0' to 'Z' (ASCII) excluding '@'.

v = determines if the existing data is deleted

0 = Do not delete, all data is left intact

1 = Reset data, all data queues are reinitialized and parameters reset to defaults

2 = All parameters are left intact. Data queues reallocated (data destroyed).

RESPONSE

The software version string will be displayed out the configuration port.

EXAMPLES:

**#Y 0 0** to restart the data board while keeping data intact

**#Y 0 1** to restart the data board and reinitialize all data and parameters

**#Y 0 2** to restart the data board and reallocate data queues. All parameters are left intact.

**For versions >= 2.0 the following are required.**

**#Y 0 0 12345** to restart the data board while keeping data intact

**#Y 0 1 12345** to restart the data board and reinitialize all data and parameters

**#Y 0 2 12345** to restart the data board and reallocate data queues. All parameters are left intact.



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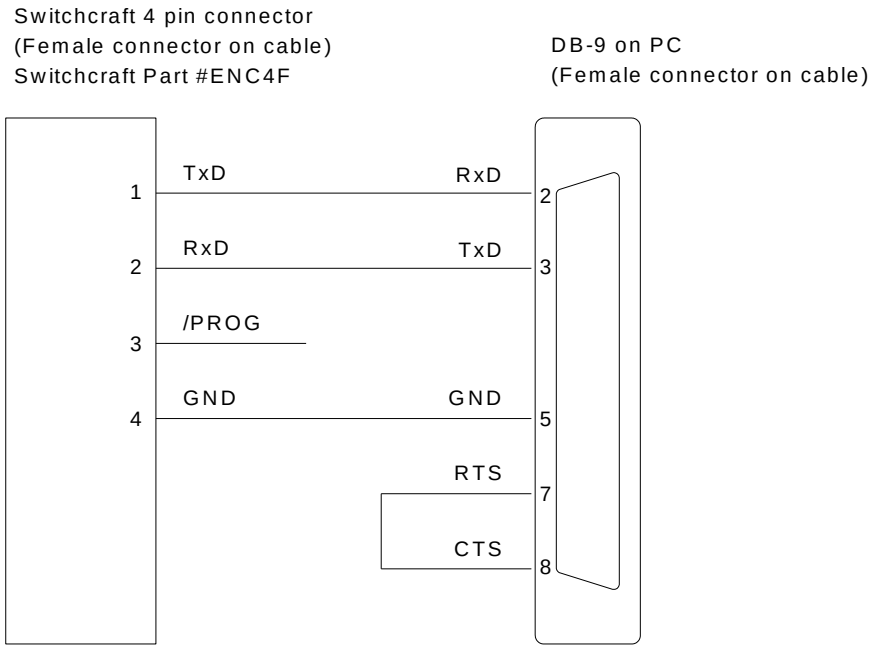
# Interconnecting Cable Pin outs

**S131-232-001**
**Serial Cable to connect Data Acquisition Board COM 1 to PC**
**DB-9 (Not for Programming Device)**



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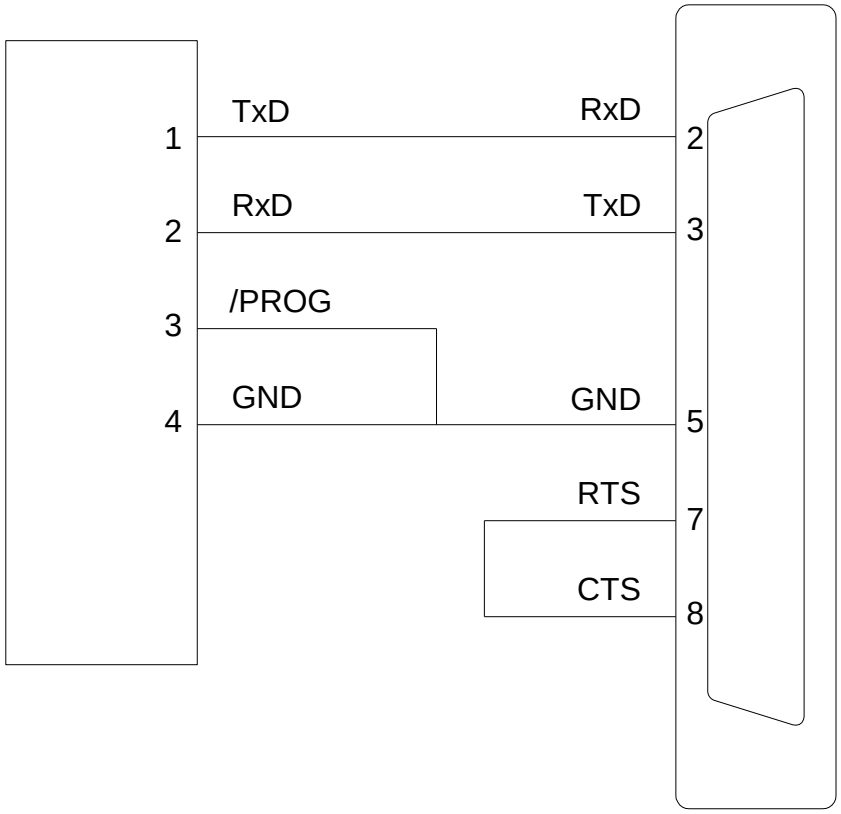
**Programming Cable to connect Data Acquisition Board to PC**

Switchcraft 4 pin connector
(Female connector on cable)
Switchcraft Part #ENC4F

DB-9 on PC
(Female connector on cable)




The programming cable is identical to the standard serial cable except the /PROG signal coming out of the board is tied to ground.



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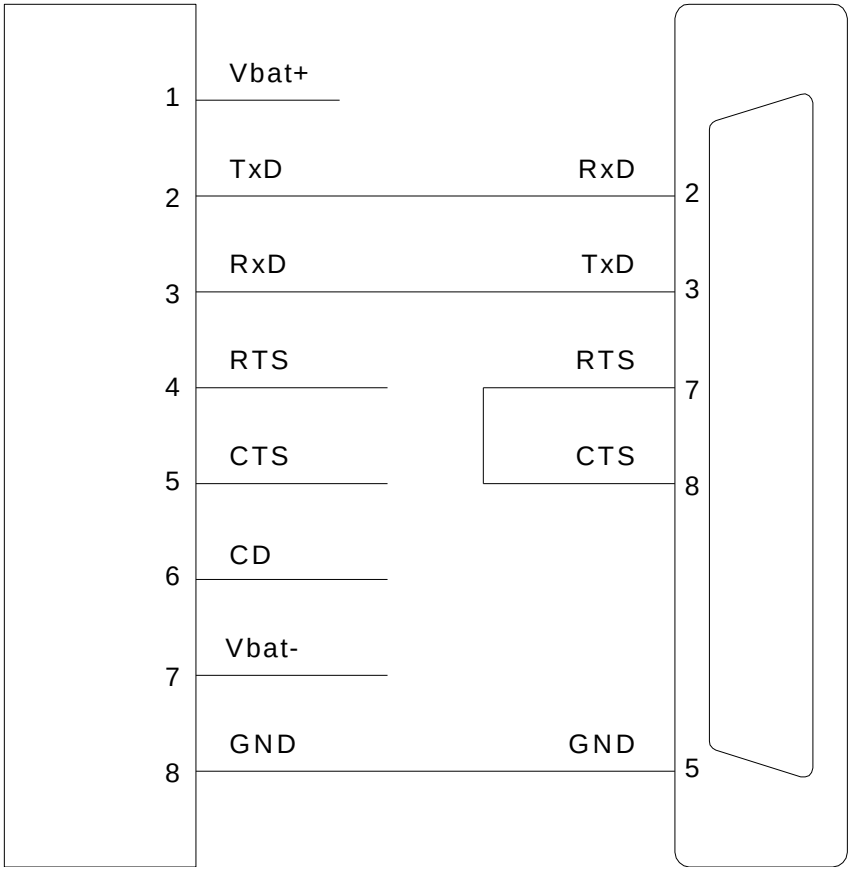
**S131-232-002**
**Serial Cable to connect Data Acquisition Board COM 2 to PC DB-9 (Not for Programming Device)**

Switchcraft 8 pin connector
(Female connector on cable)
Switchcraft Part #ENC8F

DB-9 on PC
(Female connector on cable)



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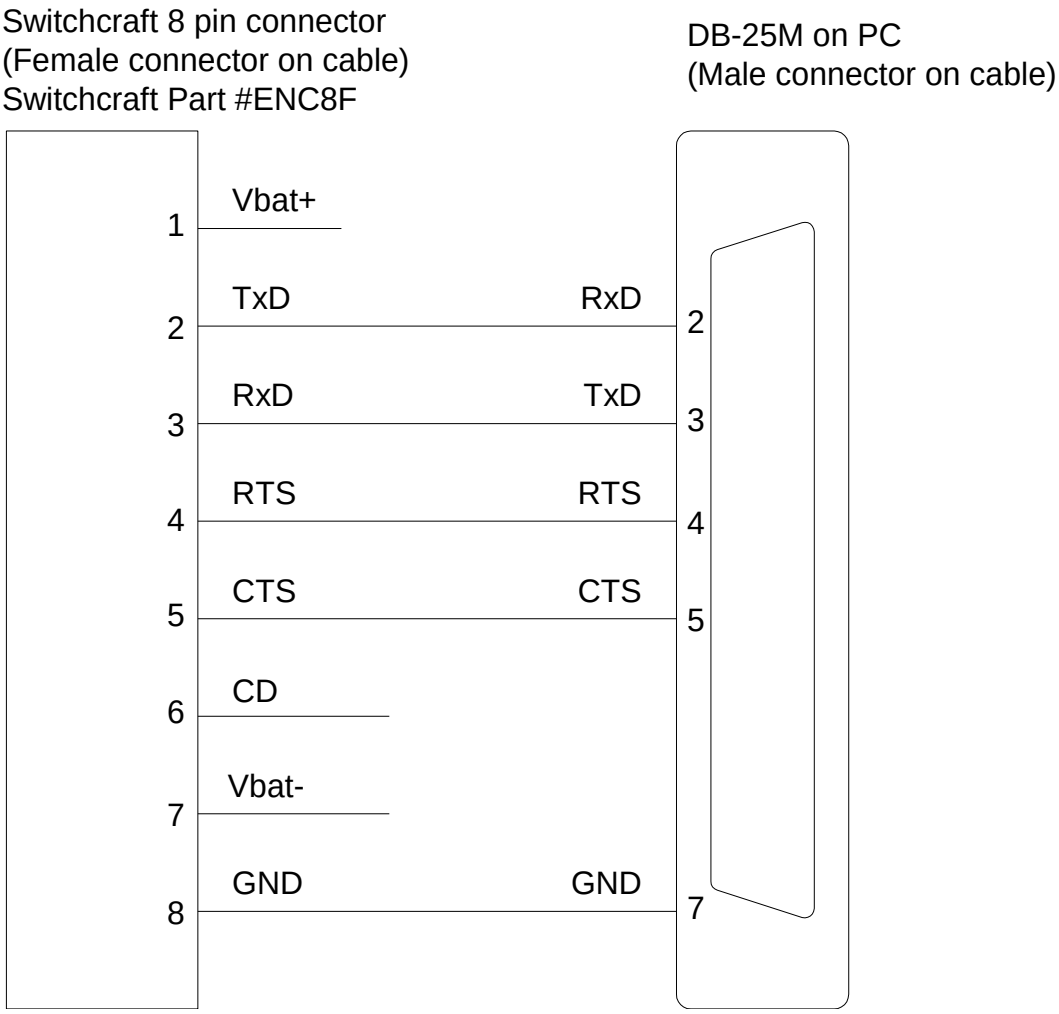
**Serial Cable to connect Data Acquisition Board COM 2 to External Modem (Not for Programming Device)**



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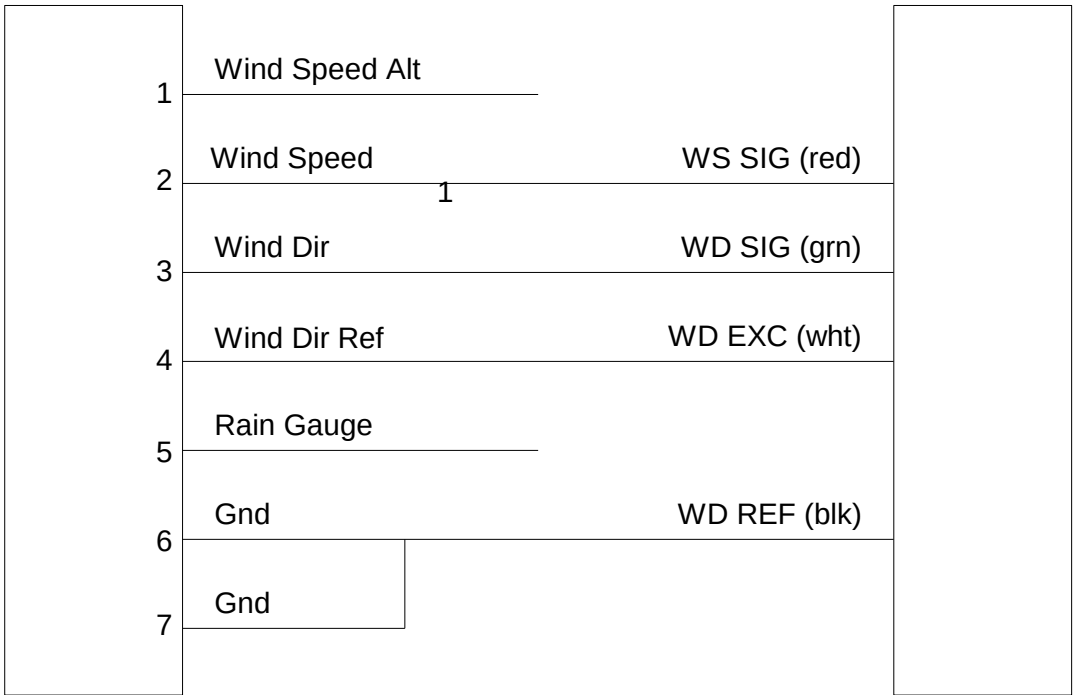
## RSS-131 to Young Wind Monitor-JR Model 05103

Switchcraft 7 pin connector (Female connector on cable)
Switchcraft Part #ENC7F

Young Junction Box



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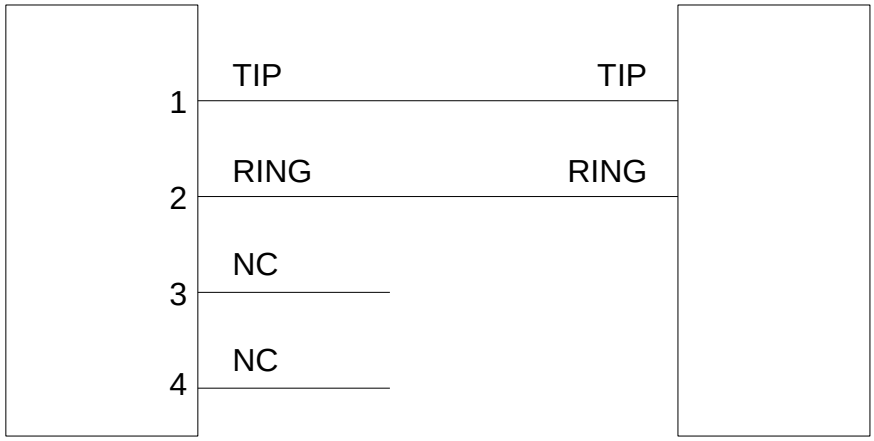
**Serial Cable to connect Modem (P3)**
**to RJ-11 Jack**

Switchcraft 4 pin connector
(Female connector on cable)
Switchcraft Part #ENC4F

RJ-11 Connector



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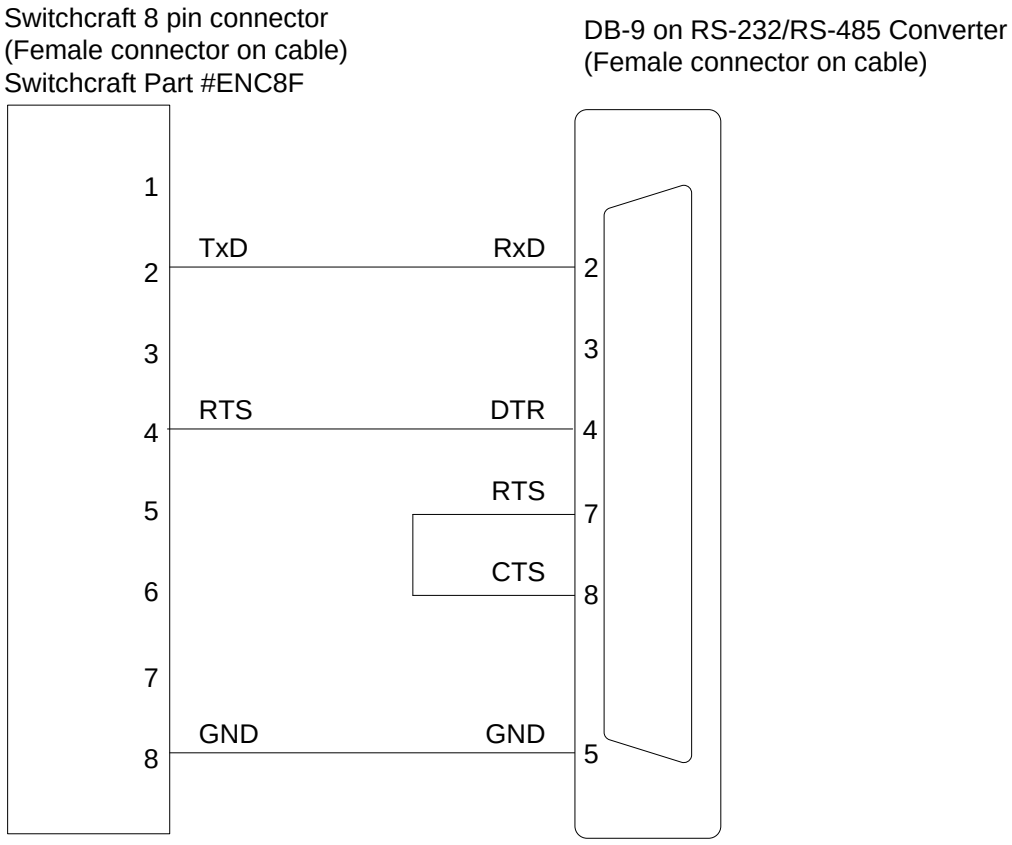
**S131-232-005**
**Cable to connect RSS-131 COM2/4 to RS-485 Converter (DEV27-1)**



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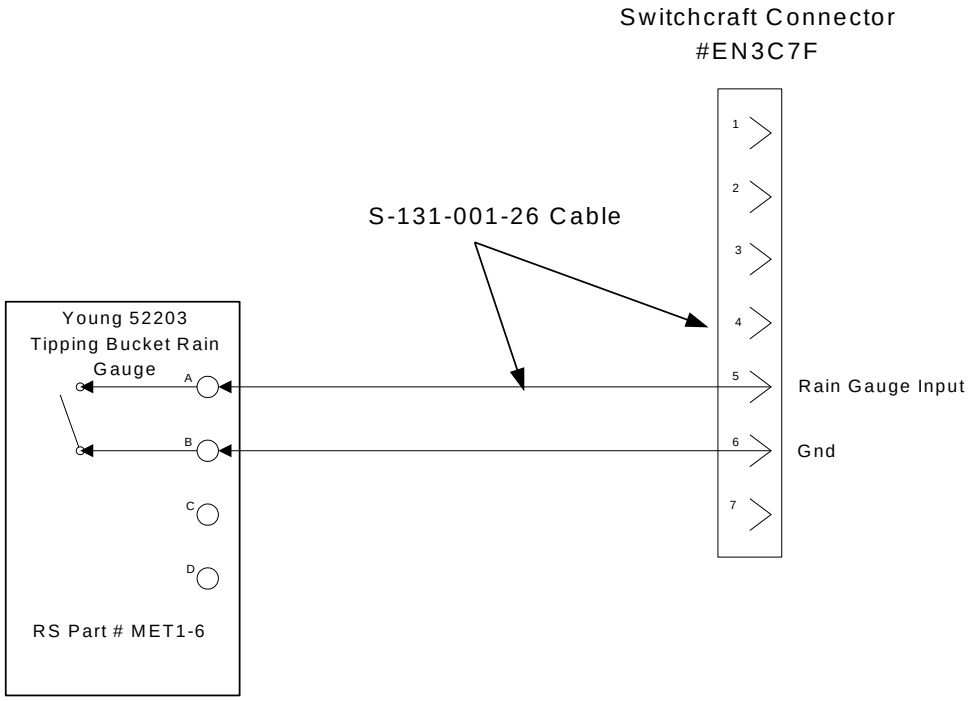
# Tipping Bucket Rain Gauge Assembly
# RS Part # S131-TB-001




Note: This assembly assumes there are no wind speed or wind direction devices connected to the 131. These devices share a connector with the rain gauge and would alter the pinout of the cable.



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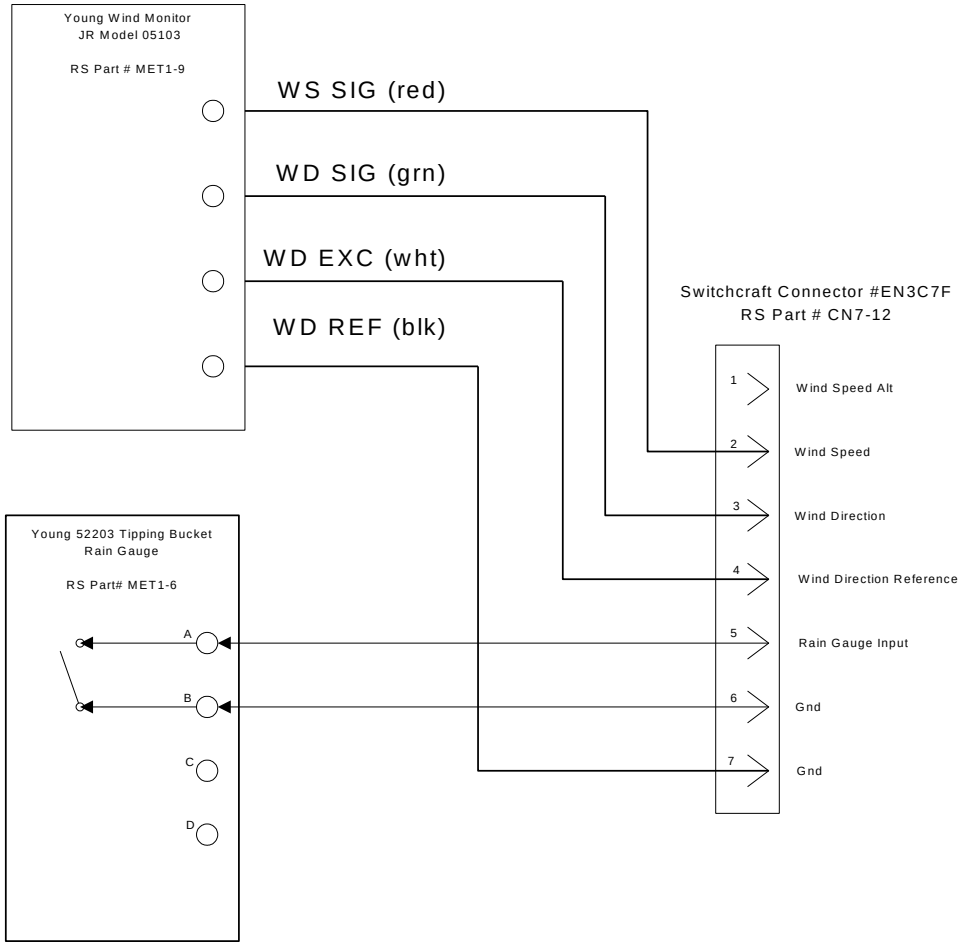
# Tipping Bucket Rain / Wind Sensor Cable Assembly RS Part # S131-TBWS-001




Note: Wire should be stripped back ½" and tinned



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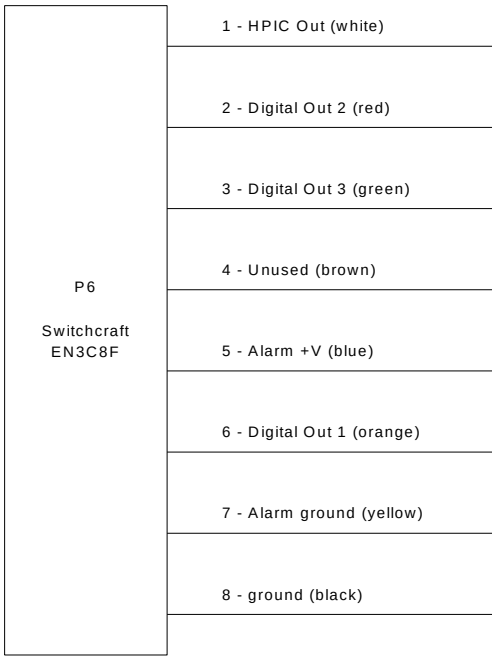
# Analog Cable for External IO Connector (P6)


P6
Switchcraft
EN3C8F
1 - HPIC Out (white)
2 - Digital Out 2 (red)
3 - Digital Out 3 (green)
4 - Unused (brown)
5 - Alarm +V (blue)
6 - Digital Out 1 (orange)
7 - Alarm ground (yellow)
8 - ground (black)

Wires are left as tinned flying leads

All wire is 24 gauge

**Analog outputs on this connector are not calibrated and not temperature compensated.**

Digital Out 1 and Digital Out 2 indicate the electrometer range as follows:

| Digital Out 1 | Digital Out 2 | Range |
|---|---|---|
| 0 | 0 | Low |
| 1 | 0 | Mid (Sensitivity invalid) |
| 0 | 1 | High (Sensitivity invalid) |
| 1 | 1 | Zero |



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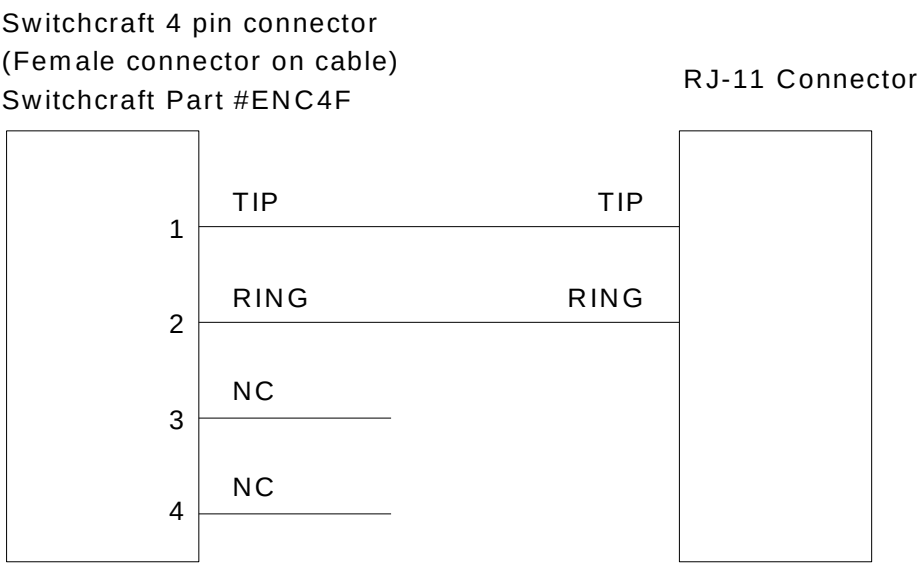
**Serial Cable to connect Modem (COM3) to RJ-11 Jack**



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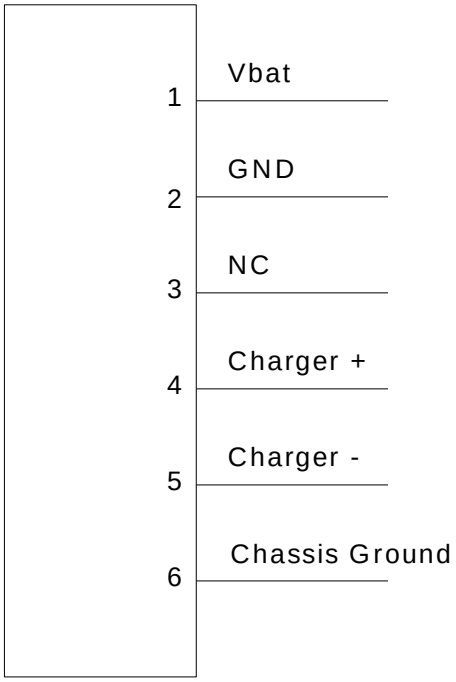
**Power Cable with Charger**
**Connects External Power to Charger**

Switchcraft Part
#EN3C6F



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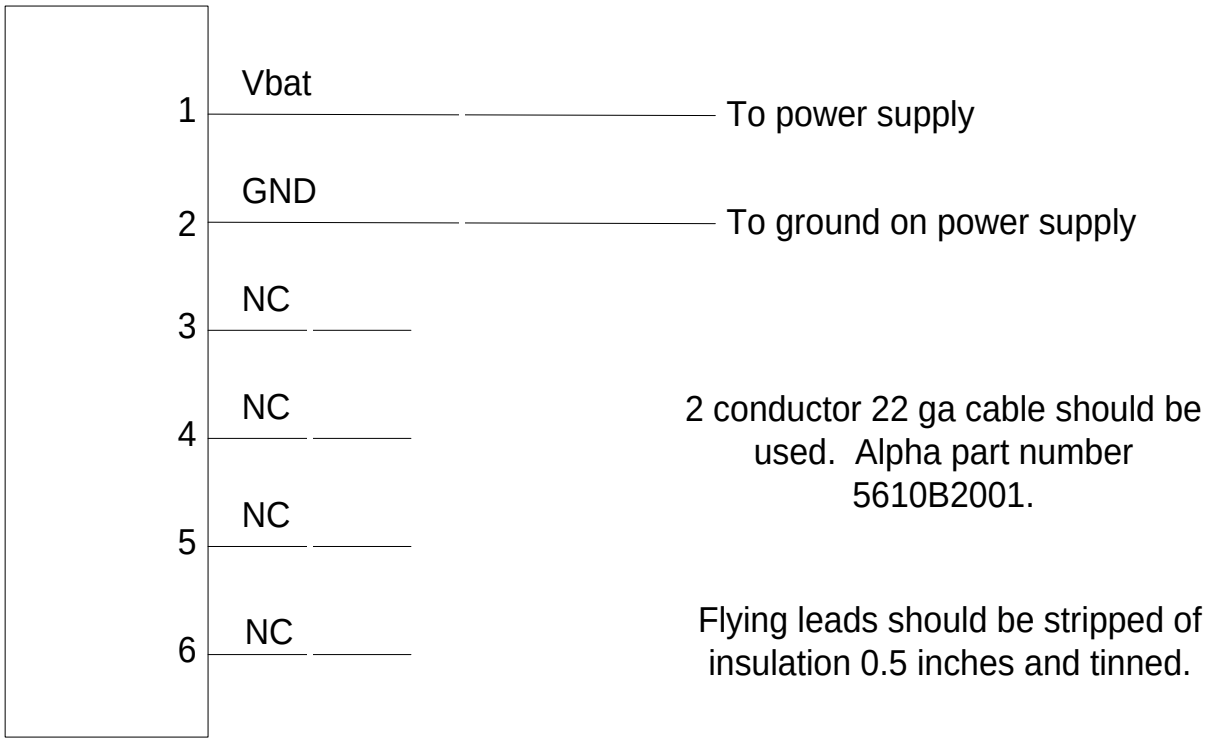
# Cable to connect external 6 to 8 V power supply to External Power connector on RS-131

Switchcraft Part
#EN3C6F
RS #CN7-11




2 conductor 22 ga cable should be used. Alpha part number 5610B2001.

Flying leads should be stripped of insulation 0.5 inches and tinned.



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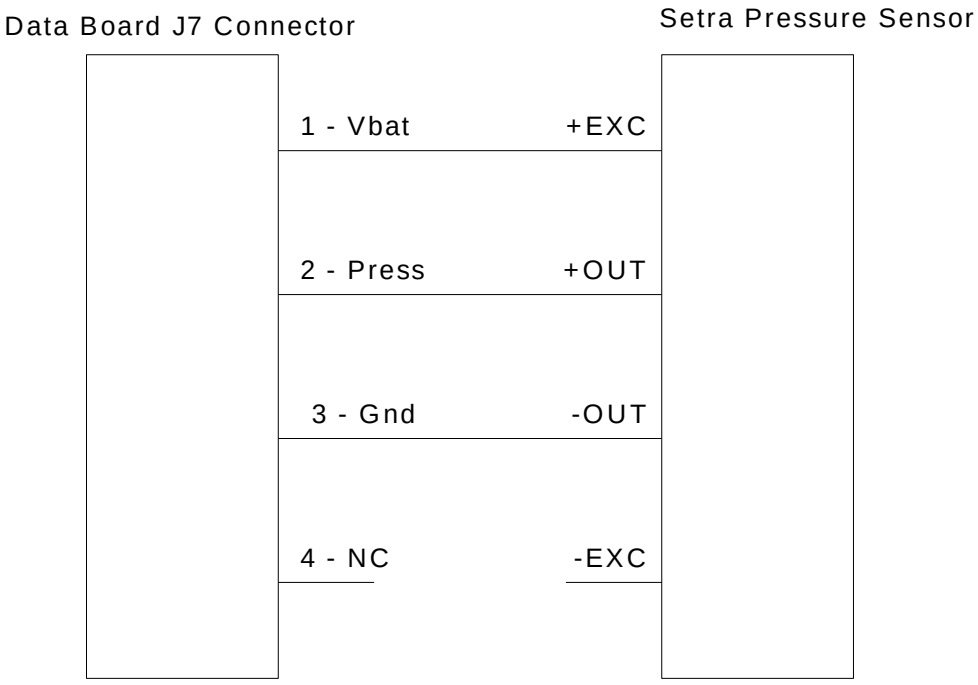
# Internal Wiring Diagrams

**Internal Pressure Sensor Cable**



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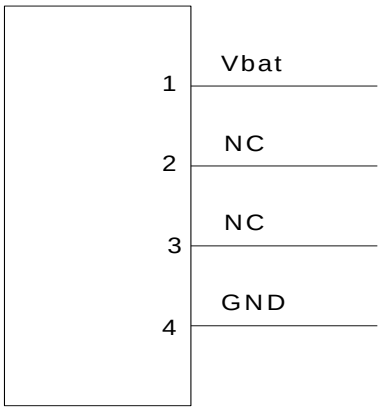
**Power Cable without Charger**
**Connects J4 to 6V Supply**

Housing Molex Part
#22-01-3047



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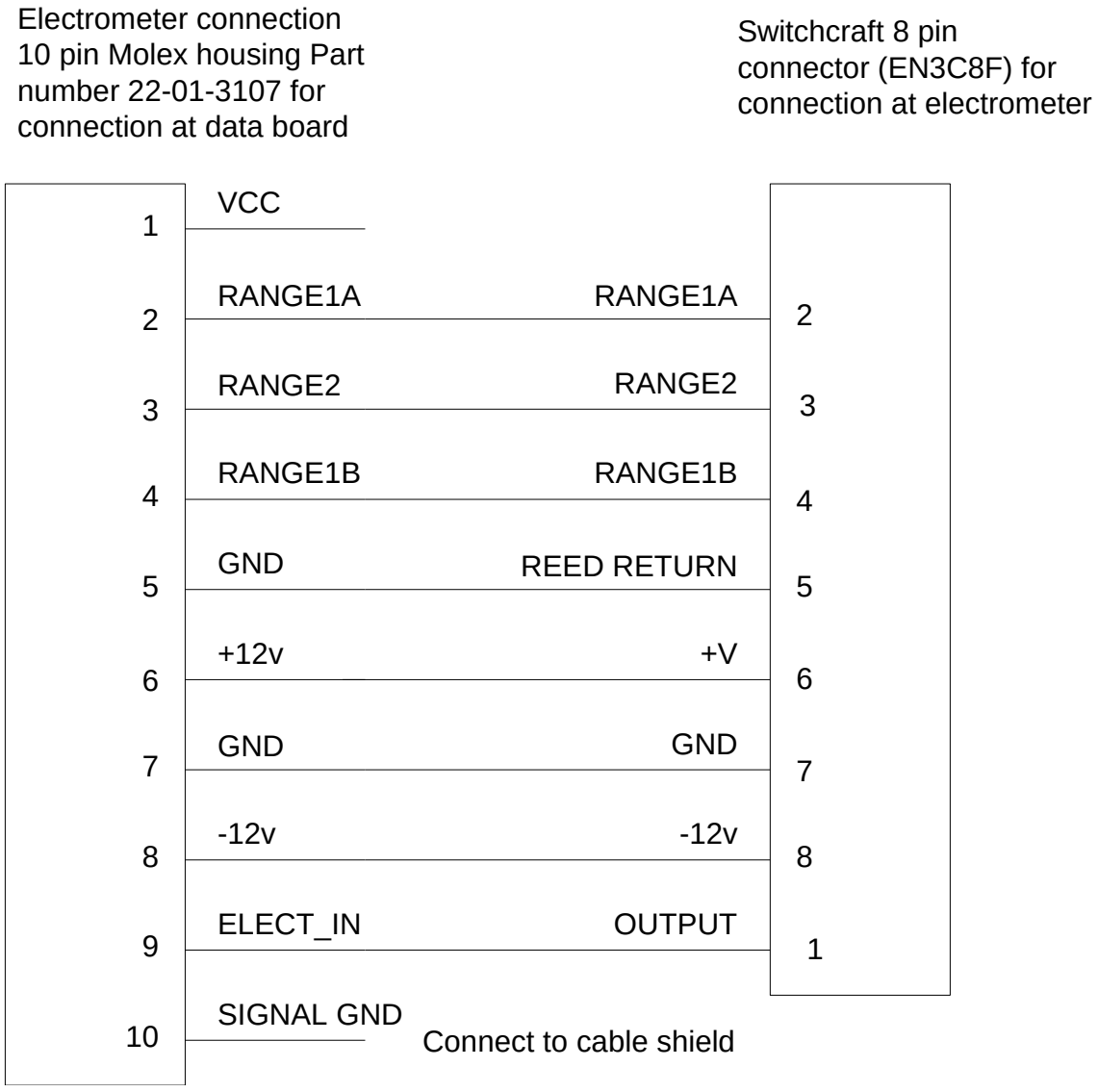
**Internal cable to connect electrometer to data board**



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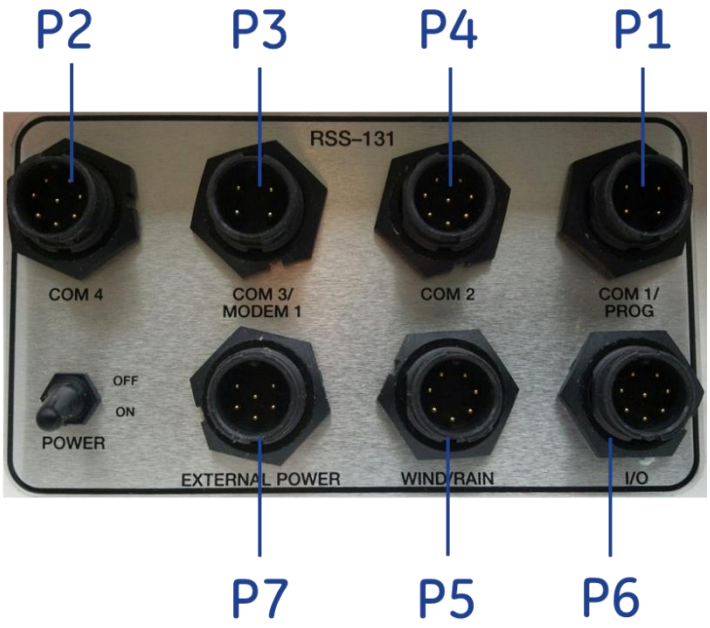
External Connectors




## P1 – COM1 Serial / Programming Port

| Pin | Function |
|---|---|
| 1 | TxD - Data sent from RSS-131 |
| 2 | RxD - Data received by RSS-131 |
| 3 | NC |
| 4 | NC |

## P2 – COM4

| Pin | Function |
|---|---|
| 1 | +12V depending on position of JP2 |
| 2 | TxD - Data sent from RSS-131 |
| 3 | RxD - Data received by RSS-131 |
| 4 | RTS |
| 5 | CTS |
| 6 | NC |
| 7 | -12V |
| 8 | GND |

## P3 – Modem / COM3

| Pin | Function |
|---|---|
| 1 | TIP - connection to phone line |



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| | |
|---|---|
| 2 | RING - connection to phone line |
| 3 | NC |
| 4 | NC |

## P4 – COM2

| Pin | Function |
|---|---|
| 1 | +12V depending on position of JP2 |
| 2 | TxD - Data sent from RSS-131 |
| 3 | RxD - Data received by RSS-131 |
| 4 | RTS |
| 5 | CTS |
| 6 | CD - Carrier Detect from radio if supported on radio |
| 7 | -12V |
| 8 | GND |

## P5 – Meteorological Sensor

| Pin | Function |
|---|---|
| 1 | WIND SPEED ALT |
| 2 | WIND SPEED |
| 3 | WIND DIRECTION |
| 4 | WIND DIRECTION REFERENCE |
| 5 | RAIN GAUGE |
| 6 | GND |
| 7 | GND |

## P6 – I / O Connector

| Pin | Function |
|---|---|
| 1 | HPIC_OUT - voltage read from electrometer |
| 2 | DIGITAL_OUT2 |
| 3 | DIGITAL_OUT3 |
| 4 | AUX1 - connected to A/D converter channel 1 input |
| 5 | ALARM +V |
| 6 | DIGITAL_OUT1 |
| 7 | ALARM GND |
| 8 | GND |

## P7 – External Power / Charger

| Pin | Function |
|---|---|
| 1 | VBAT |



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| | |
|---|---|
| 2 | GND |
| 3 | NC |
| 4 | CHARGER + |
| 5 | CHARGER - |
| 6 | CHASSIS GND |



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Internal Connectors

# J3 – Test Connector

The pinout of this connector varies depending on which version of Data Acquisition Board is present in the system. To determine which type of board is present, examine the text around the Switchcraft connector at P2 on the board.

### DAQ Board with Daughterboard Port at P2

This board was used on only the very early RSS-131 units (until late 1998).

| Pin | Name | Description |
|---|---|---|
| 1 | A/D TEST | Input to A/D channel 0 after it passes through a divider network. Channel 0 is not used in the system. |
| 2 | CH1 | Input to A/D channel 1. Channel 1 is not used in the system. |
| 3 | CH2 | Input to A/D channel 2. This is the barometric pressure sensor if present. |
| 4 | CH4 | Input to A/D channel 4 . This is the electrometer output after it passes through a divider network. |
| 5 | RXD | Received data line for COM1 |
| 6 | CH3 | Input to A/D channel 3. This is the wind direction sensor after it passes through a divider network. |
| 7 | HPIC_OUT | Output of the electrometer after it passes through a divider network. It is also available on P6 pin 1. |
| 8 | +VBAT | Battery voltage after passing through a fuse. |
| 9 | WIND_SPEED_ALT | Wind speed ALT signal |
| 10 | DIGITAL_OUT2 | Optically isolated output controlled by serial commands. Also available on P6 pin 2. |
| 11 | TXD | Transmit data line for COM1. |
| 12 | +VBATT | Battery voltage direct from the battery |
| 13 | /PF | /PF signal on DS2251T micro-controller module |
| 14 | NC | No connection |
| 15 | SPI_MISO | SPI Master In Slave Out signal (from devices to DS2251T). |
| 16 | VCC | +5V regulated voltage |
| 17 | NC | No connection |
| 18 | SPI_CLK | SPI Clock signal |



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| | | |
|---|---|---|
| 19 | SPI_MOSI | SPI Master Out Slave In signal (from DS2251T to devices). |
| 20 | -12V | -12V regulated voltage |
| 21 | CH0 | Input to A/D channel 0 with nodivider network. Channel 0 is not used in the system. |
| 22 | DIGITAL_OUT3 | Optically isolated output controlled by serial commands. Also available on P6 pin 3. |
| 23 | /PROG | /PROG pin on DS2251T used to place micro-controller in bootstrap programming mode. |
| 24 | CH6 | Input to A/D channel 6 . This is the battery voltage output after it passes through a divider network. |
| 25 | CH7 | Input to A/D channel 7 . This is the temperature output with no divider network. |
| 26 | -300V_MON | Input to A/D channel 5 . This is the bias voltage output after it passes through a divider network. |
| 27 | +12V | +12V regulated voltage |
| 28 | WIND_SPEED_PULSE | Wind speed pulses received from wind sensor |
| 29 | DIGITAL_OUT1 | Optically isolated output controlled by serial commands. Also available on P6 pin 6. |
| 30 | AUX1 | Not used |
| 31 | NC | No connection |
| 32 | NC | No connection |
| 33 | GND | Ground |
| 34 | GND | Ground |



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## DAQ Board with COM4 text at P2

This board replaced the earlier board that had the daughterboard connection. This board has been used on all newer RSS-131 units (since late 1998).

| Pin | Name | Description |
|---|---|---|
| 1 | NC | No connection |
| 2 | NC | No connection |
| 3 | CH2 | Input to A/D channel 2. This is the barometric pressure sensor if present. |
| 4 | CH4 | Input to A/D channel 4 . This is the electrometer output after it passes through a divider network. |
| 5 | RXD | Received data line for COM1 |
| 6 | CH3 | Input to A/D channel 3. This is the wind direction sensor after it passes through a divider network. |
| 7 | HPIC_OUT | Output of the electrometer after it passes through a divider network. It is also available on P6 pin 1. |
| 8 | +VBAT | Battery voltage after passing through a fuse. |
| 9 | WIND_SPEED_ALT | Wind speed ALT signal |
| 10 | DIGITAL_OUT2 | Optically isolated output controlled by serial commands. Also available on P6 pin 2. |
| 11 | TXD | Transmit data line for COM1. |
| 12 | +VBATT | Battery voltage direct from the battery |
| 13 | /PF | /PF signal on DS2251T micro-controller module |
| 14 | NC | No connection |
| 15 | SPI_MISO | SPI Master In Slave Out signal (from devices to DS2251T). |
| 16 | VCC | +5V regulated voltage |
| 17 | NC | No connection |
| 18 | SPI_CLK | SPI Clock signal |
| 19 | SPI_MOSI | SPI Master Out Slave In signal (from DS2251T to devices). |
| 20 | -12V | -12V regulated voltage |
| 21 | CH0 | Input to A/D channel 0 with nodivider network. Channel 0 is not used in the system. |
| 22 | DIGITAL_OUT3 | Optically isolated output controlled by serial commands. Also available |



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| | | |
|---|---|---|
| | | on P6 pin 3. |
| 23 | /PROG | /PROG pin on DS2251T used to place micro-controller in bootstrap programming mode. |
| 24 | CH6 | Input to A/D channel 6 . This is the battery voltage output after it passes through a divider network. |
| 25 | CH7 | Input to A/D channel 7 . This is the temperature output with no divider network. |
| 26 | BIAS_MON | Input to A/D channel 5 . This is the bias voltage output after it passes through a divider network. |
| 27 | +12V | +12V regulated voltage |
| 28 | WIND_SPEED_PULSE | Wind speed pulses received from wind sensor |
| 29 | DIGITAL_OUT1 | Optically isolated output controlled by serial commands. Also available on P6 pin 6. |
| 30 | AUX1 | Not used |
| 31 | ELECT_IN | Direct input to DAQ board from electrometer with no divider network. |
| 32 | NC | No connection |
| 33 | GND | Ground |
| 34 | GND | Ground |



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Temperature Compensation

# Introduction

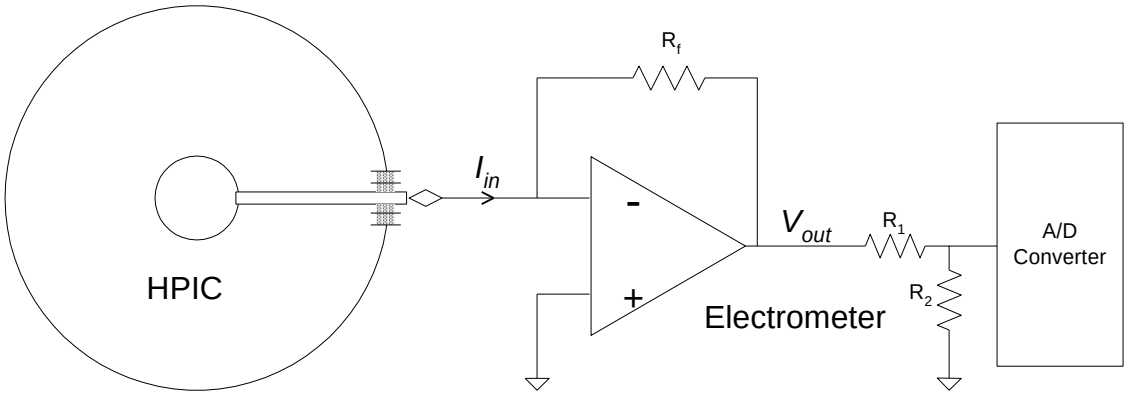
A critical aspect of accuracy and stability is the instrument sensitivity to changes in environmental conditions, particularly that of temperature. Since each sub-assembly of the RSS-131 is affected in a different way by temperature, the best method for minimizing error is to characterize each of the error components and compensate for them. Error-specific parameters are entered into the microprocessor and used by the firmware to compensate the output of the sensor to temperature changes. Since the sensor outputs are generated by the microprocessor, the usual analog circuit errors can be completely compensated. In the remainder of this section the method used to perform this compensation is described for each sensor sub-assembly, and the compensation parameters for each portion are noted.

# Sensor Sub-Assemblies

The sub-assemblies of the sensor are:

- High Pressure Ion Chamber (HPIC)
- Electrometer
- A/D Converter

Each sub-assembly has a different source of temperature-induced error. These are modeled separately as shown in the following diagram.




# HPIC

The key detector property is gamma sensitivity, expressed in amps/R/h. The gamma sensitivity is determined by gas filling, volume, wall material and thickness. Since these factors are essentially invariant over the operating temperature range of the RSS-131, temperature has no significant effect on gamma sensitivity. In addition, since all leakage currents are removed by the guard ring construction of the chamber, there is no temperature induced "offset" signal from the detector. Therefore the detector is characterized by a single



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temperature independent parameter, "RAC". A typical value for this parameter is $2.5 \times 10^{-8}$ amps/R/h.

# Electrometer

The electrometer has 3 different feedback resistors that provide three operating ranges to allow for the measurement of a wide dynamic range. For simplification only one range is shown in this section. In practice the method of compensation described applies to each range, so each of the parameters described below will occur 3 times - once for each range.

The electrometer employs an operational amplifier with the usual well-known sources of temperature-induced error. These sources are: input bias current, input offset current, input offset voltage. Also, the temperature stability of the feedback resistor is important. All of these effects can be summed together and will have the general form shown below:

$$V_{out} = A(t) * I_{in} + B(t) \qquad (1)$$

Where

$$A(t) = A1 * t + A2 \qquad (2)$$

$$B(t) = B1 * t + B2 \qquad (3)$$

And $t = temp(°C) - 25$

The A(t) term represents the feedback resistance of the electrometer as a function of temperature and the B(t) term describes the electrometer offset voltage as a function of temperature.



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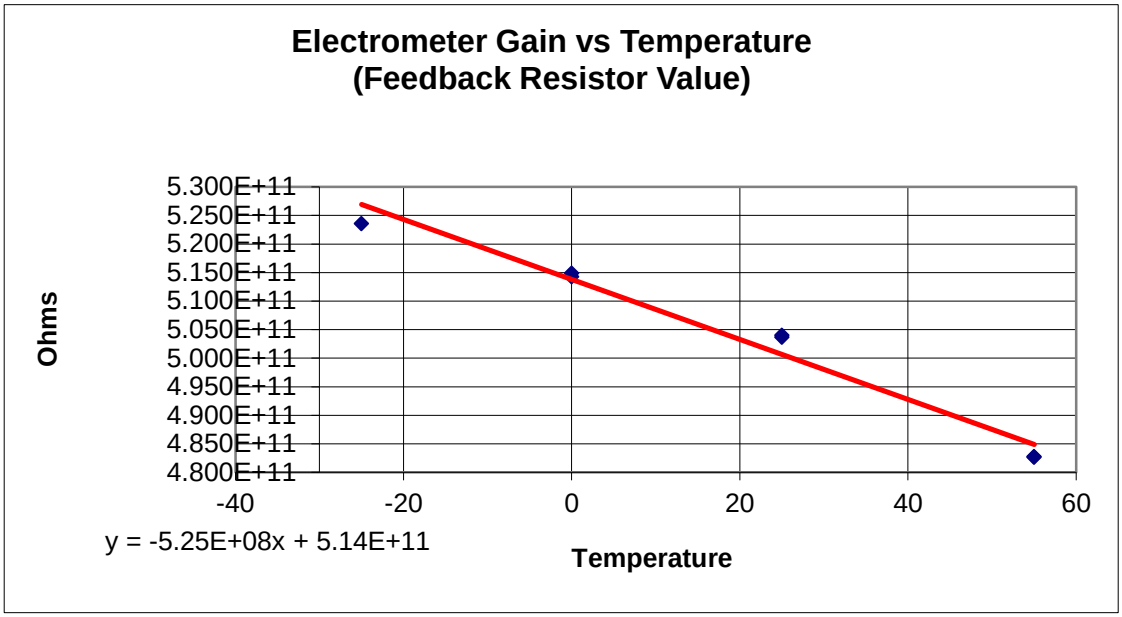
The graph shown below is the measured value of the feedback resistance of the electrometer vs. temperature, and a trend line indicating the least squares fit of the data. In the lower left is the equation of this line. From this equation we can compute the parameters A1 and A2 shown in equation (2) above. Since the temperature in equation (2) is t-25 the equation in the graph below must be adjusted as follows.

$$y = -5.25E+8(t+25) + 5.14E+11$$

$$y = -5.25E+8t + 5.12E+11$$

therefore A1 = -5.25E+8

A2 = 5.008E+11



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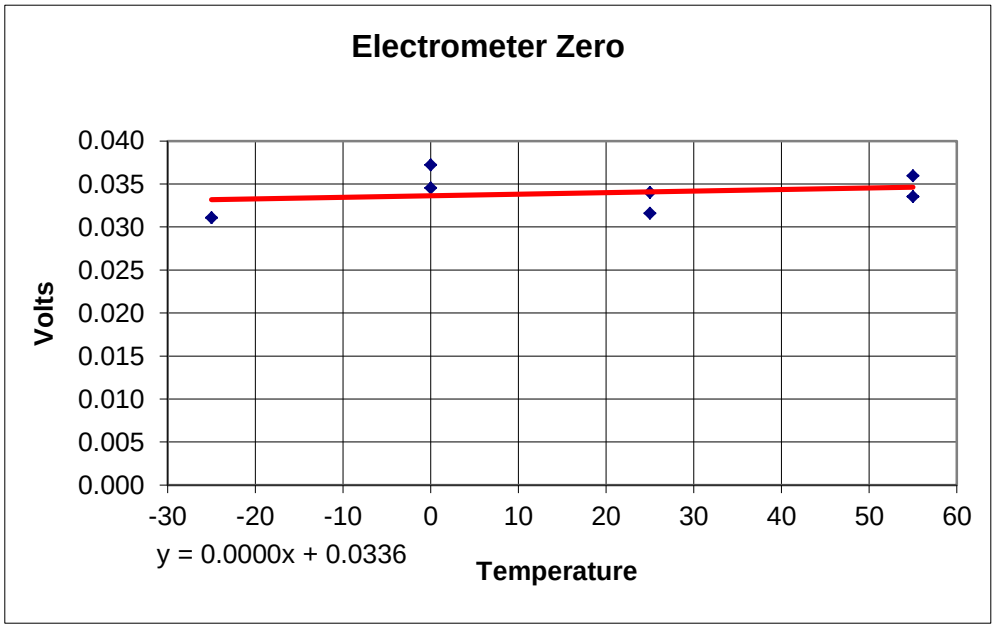
A similar analysis is performed for the electrometer zero. Data is taken for a number of temperatures and the zero is measured. A typical data set is shown below. From this equation of the least squares fit the parameters B1 and B2 can be computed. Since the temperature in equation (2) is t-25 the equation in the graph below must be adjusted as follows.

$$y = 0.00(t+25) + 0.0336$$

$$y = -0.00t + 0.0336$$

Therefore B1 = 0.00

B2 = 0.0336



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In practice there are actually 3 ranges that must be tested and parameters calculated. The table below shows the parameter names for each of the ranges. Each of these parameters is tested at the factory and entered into the system using the #P command. Printed listings of these are also supplied in the event they parameters are lost. In addition to the printed form a file is supplied which is used by the configuration utility so that the values can be easily downloaded to the RSS-131 without having to deal with individually entering the parameters.

| | Parameter Name | | | |
|---|---|---|---|---|
| | Gain | | Zero | |
| Range | A1 | A2 | B1 | B2 |
| Low | RLV | RLN | ZLD | ZLN |
| Mid | RMV | RMN | ZMD | ZMN |
| High | RHV | RHN | ZHD | ZHN |

# A/D Converter

The A/D convert has 2 parameters associated with the data conversion. First is the resistor divider ratio, which scales the voltage from the electrometer before input to the A/D. This parameter for the Electrometer input is named "AD4" and has a nominal value 2.5, which is the inverse of the resister divider ratio. The second constant is the full scale A/D value named "ADR" which nominally is 4.095, the voltage that corresponds to a digital output of 4095 from the A/D.



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Analog Output

# Introduction

As an option the analog output from the RSS-131 can be used for input to external analog input devices. This option is available by using the optional analog output cable. This output actually consists of three signals, the analog output and 2 range digital range bits, which indicate the current range of the unit. **It is important to understand that the analog output is not calibrated and not temperature compensated.**

In previous Reuter-Stokes products, such as the RSS-120 the analog output sensitivity was always 20mV/uR/h. This allowed for the interchange of sensors without any changes to the monitoring system. The philosophy of the RSS-131 is somewhat different than these older units, in that the primary calibrated output is obtained via the RS-232 port not the analog output. Calibration of the unit is done by a series of configurable parameters that are stored in the microprocessor system as described in the prior section.

The sensitivity of the RSS-131 varies from unit to unit and is specified on the calibration sheet shipped from the factory each time the unit is calibrated. A typical value would be between 13 and 15 mV/uR/hr. If radiation data is obtained by connecting the analog output to a data logger the data logger must be programmed to use the sensitivity specified on the RSS-131 calibration sheet. **This sensitivity is valid only for the low range (less than 750 uR/hr). In the mid and high ranges the analog output sensitivity is invalid.**



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# Output Calibration

Since the output is not calibrated a calculation must be performed to apply the necessary adjustment to convert the voltage to a R/h value. In general the form of the calculation is as follows.

$$\text{Exposure(R/h)} = (V - B(t)) / (A(t) * RAC)$$

Where

$A(t) = A1 * t + A2$

$B(t) = B1 * t + B2$

RAC = the calibration constant provided

And t = temp(°C) - 25

To determine the A1,A2, B1 & B2 values you must first know the range of the sensor. The following table shows the sensor range as a function of the range output. Once the range is known, i.e. Low, Mid or High look at the next table to see which parameters will be used in the calculation.

| DIGITAL_OUT1 | DIGITAL_OUT2 | Range |
|---|---|---|
| 0 | 0 | Low |
| 1 | 0 | Medium |
| 0 | 1 | High |

Digital Output Range

| | Parameter Name | | | |
|---|---|---|---|---|
| | Gain | | Zero | |
| Range | A1 | A2 | B1 | B2 |
| Low | RLV | RLN | ZLD | ZLN |
| Mid | RMV | RMN | ZMD | ZMN |
| High | RHV | RHN | ZHD | ZHN |

Parameters used in Sensitivity calculations

For example if the unit is in the low range and the temperature was 25°C then A9(t) and B(t) would be:

$A(25) = RLV * (0) + RLN$

$A(25) = RLN$



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$$B(25) = ZLD * (0) + ZLN$$

$$B(25) = ZLN$$

As a result

$$Exposure(R/h) = (V - ZLN) / (RLN * RAC)$$

If V = 1.0V, ZLN = 0.00 and RLN is $5 \times 10^{11}$ and RAC = RAC = $2.61 \times 10^{-8}$ then.

$$Exposure(R/h) = (1.0 - 0.00) / (5 \times 10^{11} * 2.61 \times 10^{-8})$$

$$Exposure(R/h) = 7.66 \times 10^{-5} \quad (76.6uR/h)$$



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# Failure Modes

## Unit Does Not Change Ranges Correctly

As mentioned previously, the electrometer constants are critical to both accurate radiation readings and correct range changes. If incorrect electrometer constants are used in the unit, it will typically change from low to mid range properly but will not change back to low range.

If a unit is observed not changing ranges correctly, verify it has the correct electrometer constants. They can be reloaded from the configuration file shipped with the unit. They can also be compared to the values on the most recent calibration certificate (these are the same as those found in the configuration file).

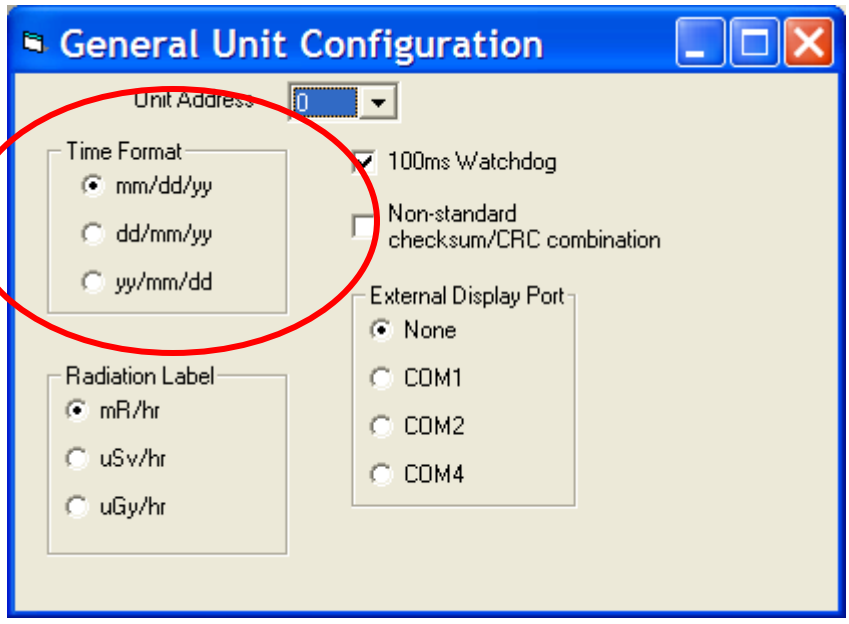
## No Data Retrieved From Unit

The RSS-131 will always record data. If the user is unable to retrieve data from the RSS-131 it is likely there is an issue with date and/or time settings on the PC.

The user should verify the date format on the RSS-131 matches the Regional Settings date format on the PC. The PC format must match **exactly** the RSS-131 format. The RSS-131 supports only the following date formats:

- mm/dd/yy
- dd/mm/yy
- yy/mm/dd

The RSS-131 date format can be seen in the General Configuration window.



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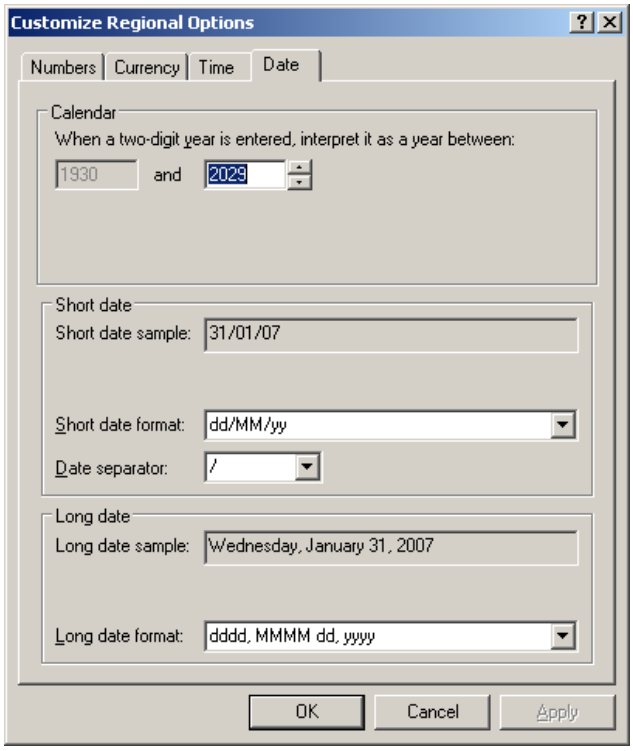
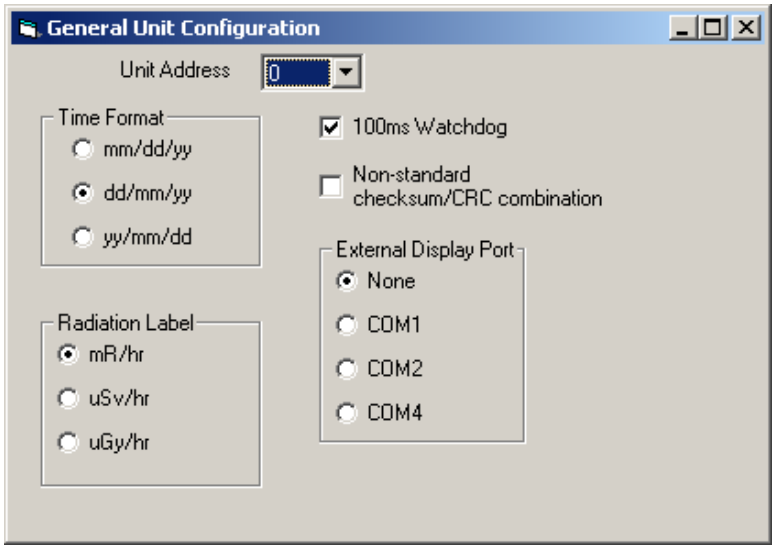
# Detailed Date Format Examples

Users that use the dd/mm/yy date format should configure their PC and RSS-131 exactly as shown below.



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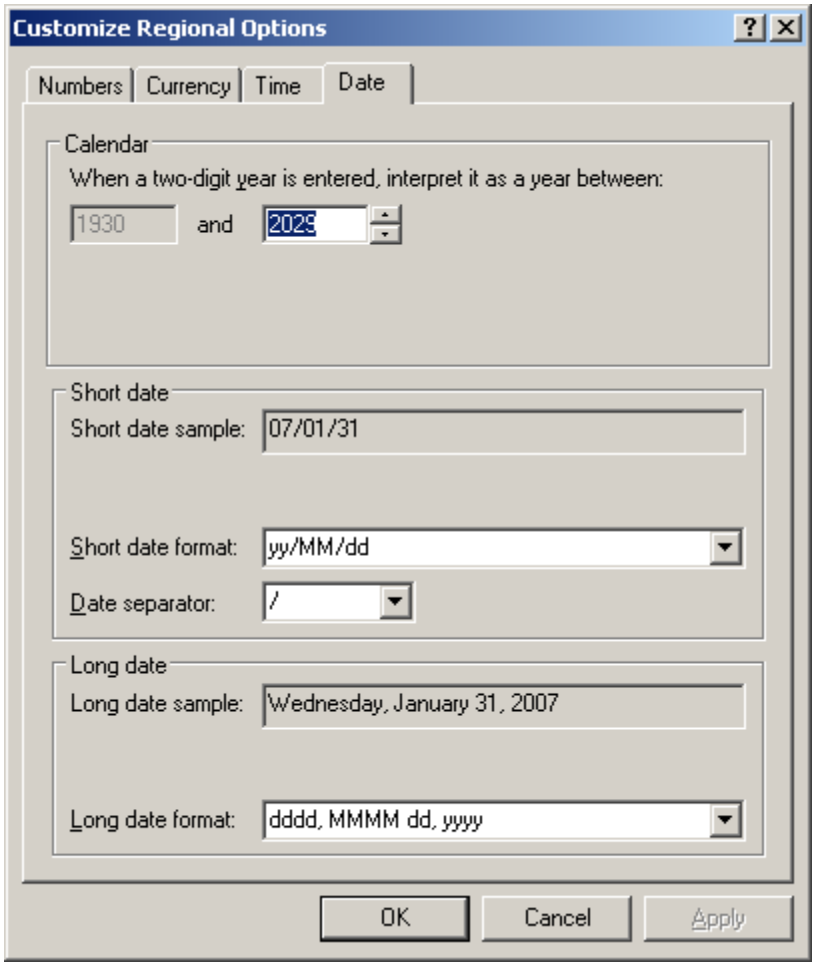
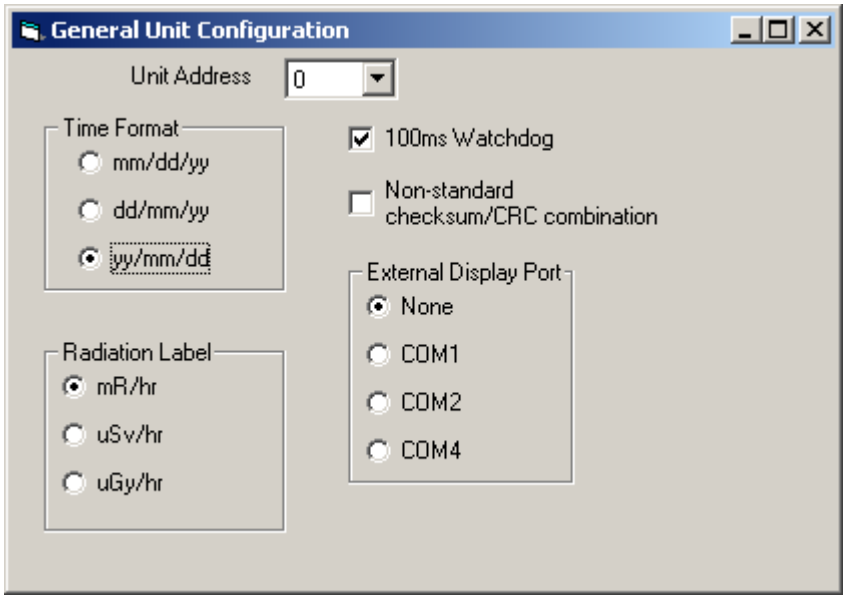
Users that use the yy/mm/dd date format should configure their PC and RSS-131 exactly as shown below.



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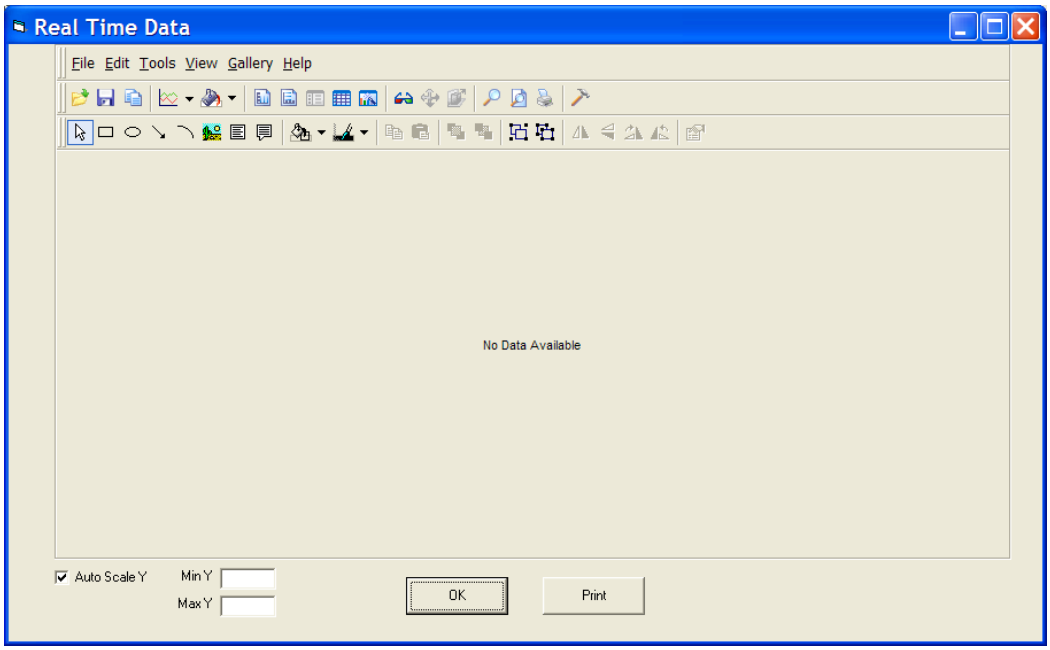
## No Data Displayed While Graphing Real-Time Data

Real-time graphing requires a few seconds to retrieve initial values before graphing. If the graph does not begin to update after a few seconds a problem may exist (the graph will look as shown below).




Several conditions may exist which could prevent real-time data from graphing. If the graph does not update, check the following:

- Make sure the date and time formats on the PC and RSS-131 match exactly (refer to Detailed Date Format Examples above for details).
- There may be no data recorded in the unit. Allow time for at least two values to be recorded based on the sensor settings.
- The RSS-131 may not be communicating with the PC (refer to No Communications with RSS-131 below for details.



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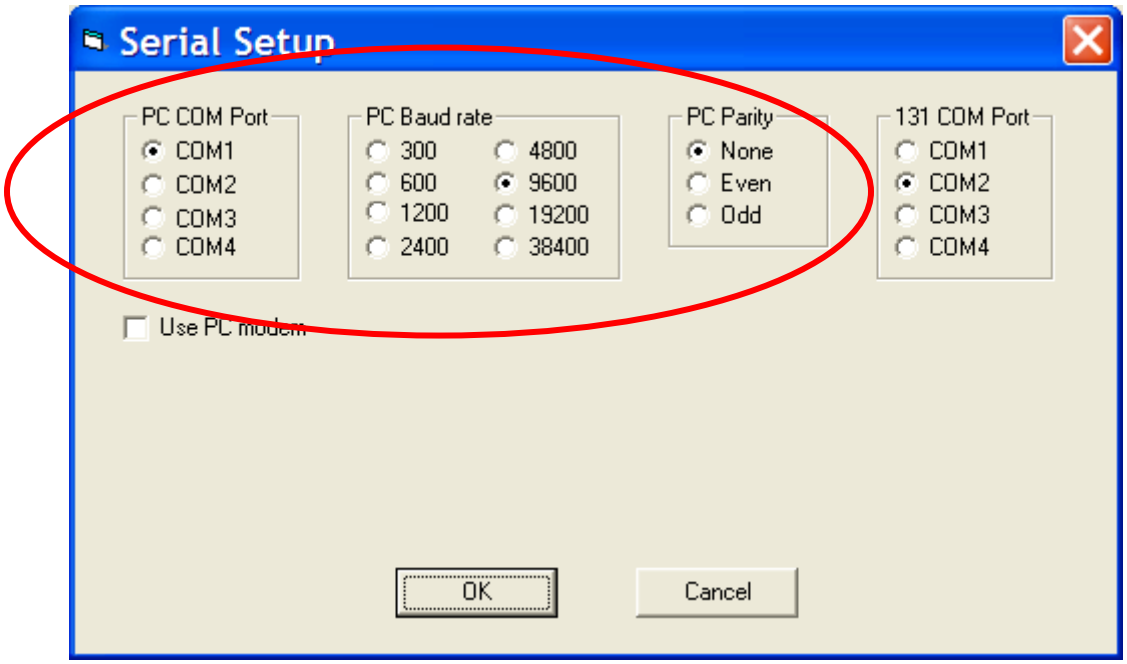
## No Communications with RSS-131

Communication parameters must match exactly between the PC and RSS-131. The PC settings are modified using the PC...Serial Config menu option. The PC settings should match the current settings of the RSS-131.



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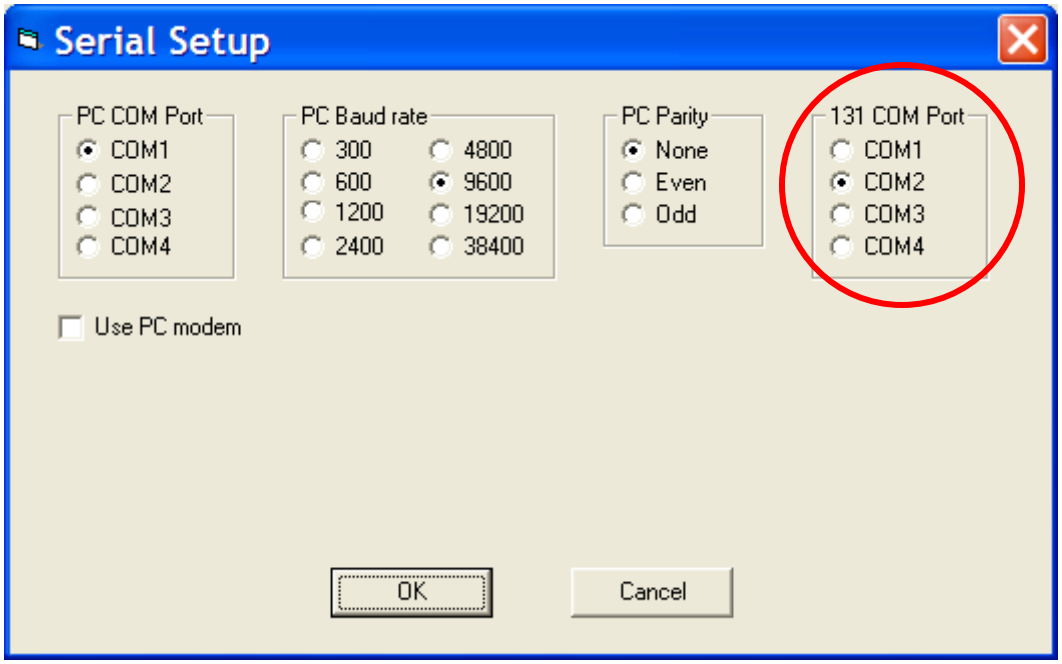
## Communications Fail Partway Through Parameter Download

Another critical consideration on the PC...Serial Config window is selection of the RSS-131 COM port that is physically connected to the PC. Communication parameters for the RSS-131 COM port are changed on the Configuration...Communications window.




Most parameters take effect immediately once they are downloaded to the RSS-131. This includes communication parameters. If the Configuration Utility is configured for one serial port in the Serial Setup window and settings for the RSS-131 serial port that is actually connected to the PC (different from the Serial Setup port that is selected) are changed, parameter download will proceed with no errors until the RSS-131 COM port is reconfigured, at which time communications will fail.

To correct this situation, reconfigure the PC COM port as described previously to match the RSS-131 COM port settings.



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# Troubleshooting Flowcharts



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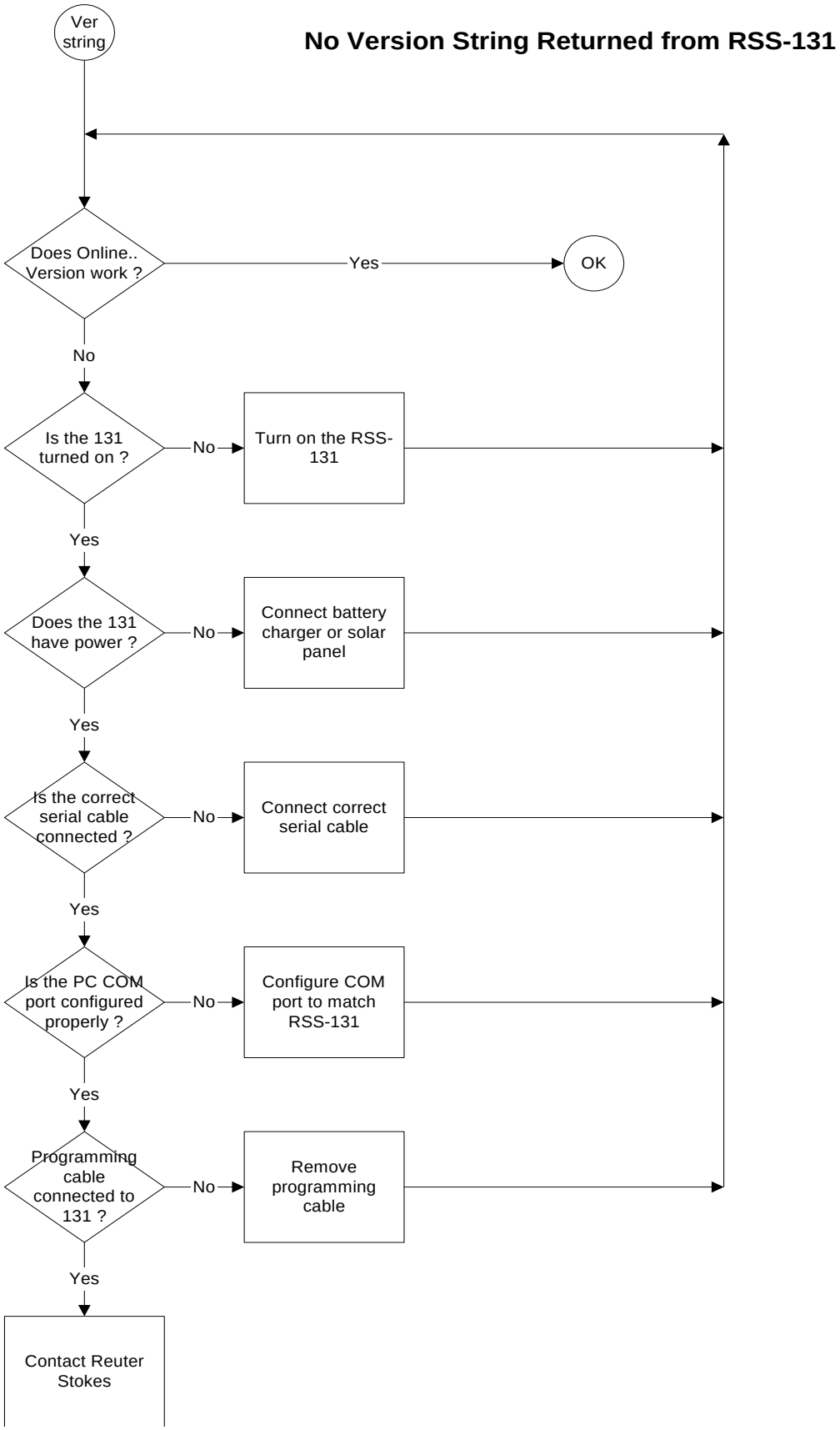
## No Version String Returned from RSS-131



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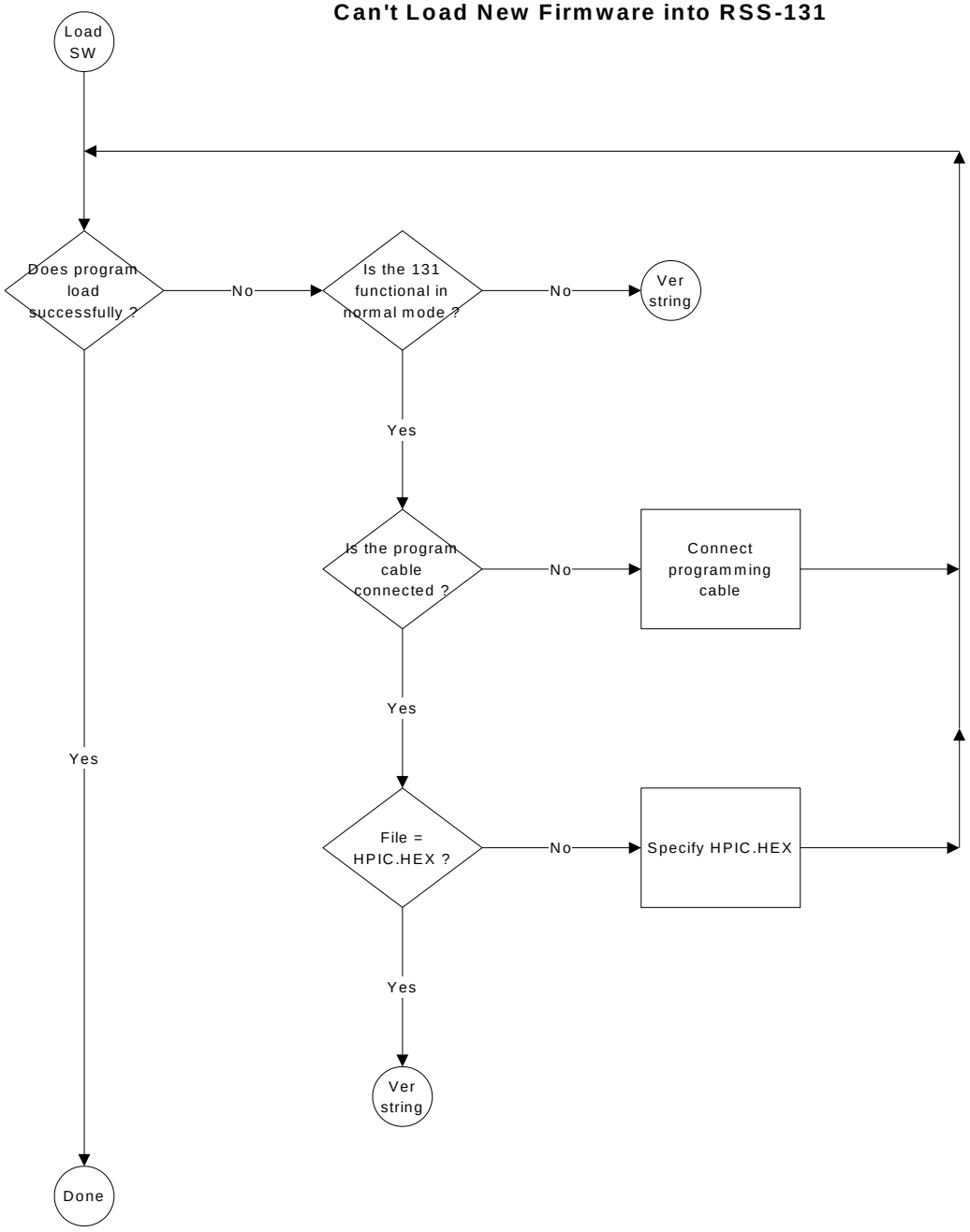
**Can't Load New Firmware into RSS-131**



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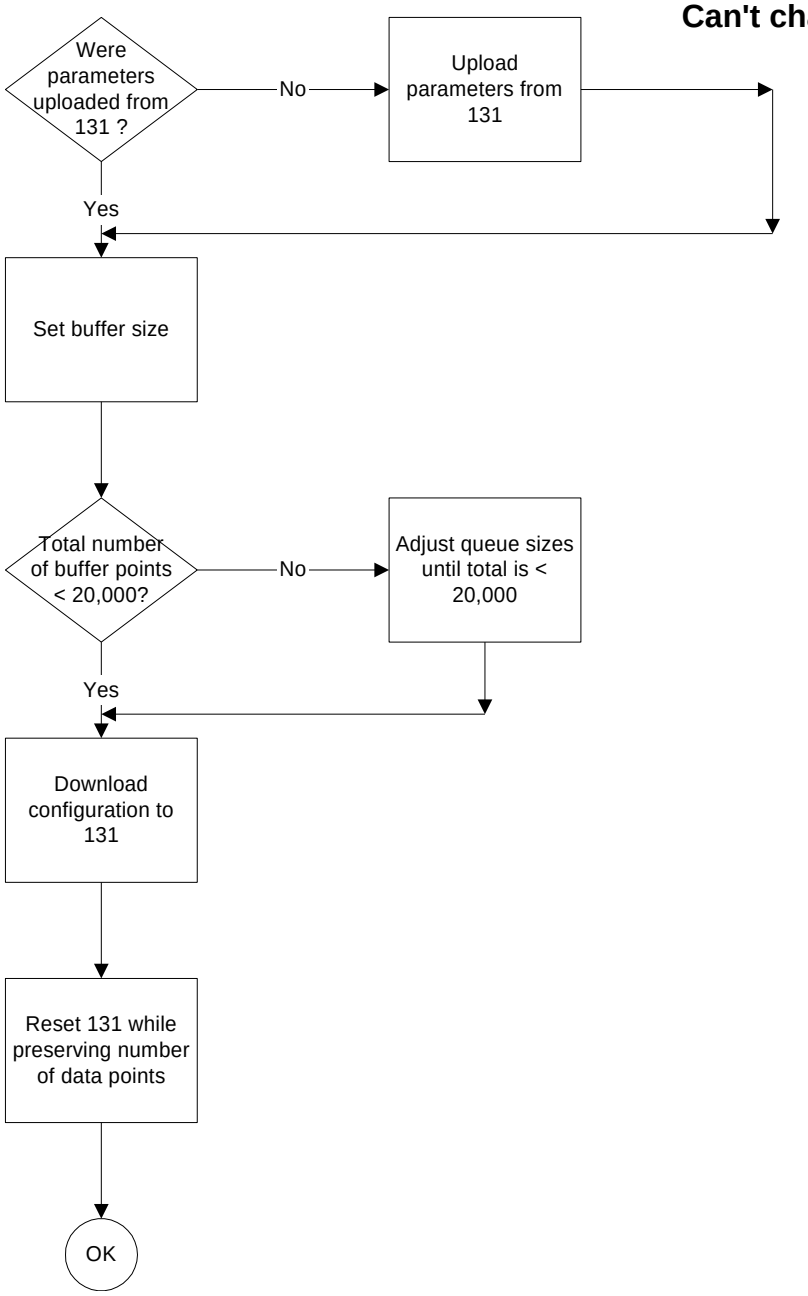
**Can't change queue size for a sensor**



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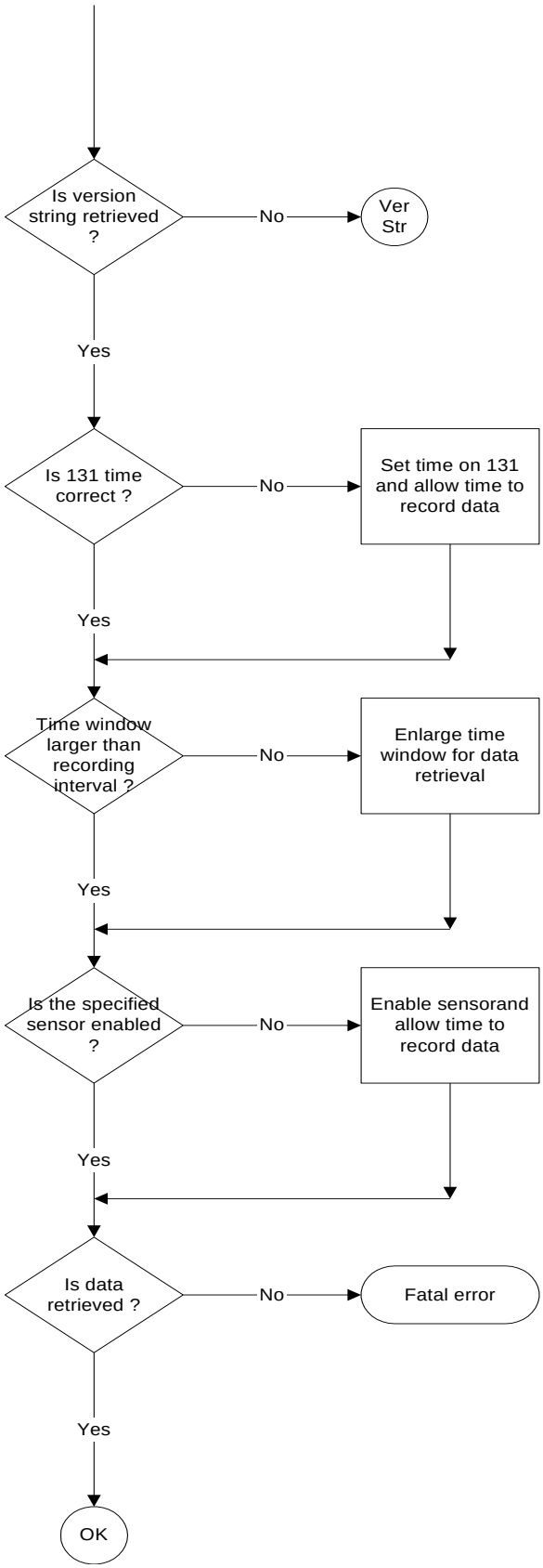
**No Sensor Data Retrieved from 131**



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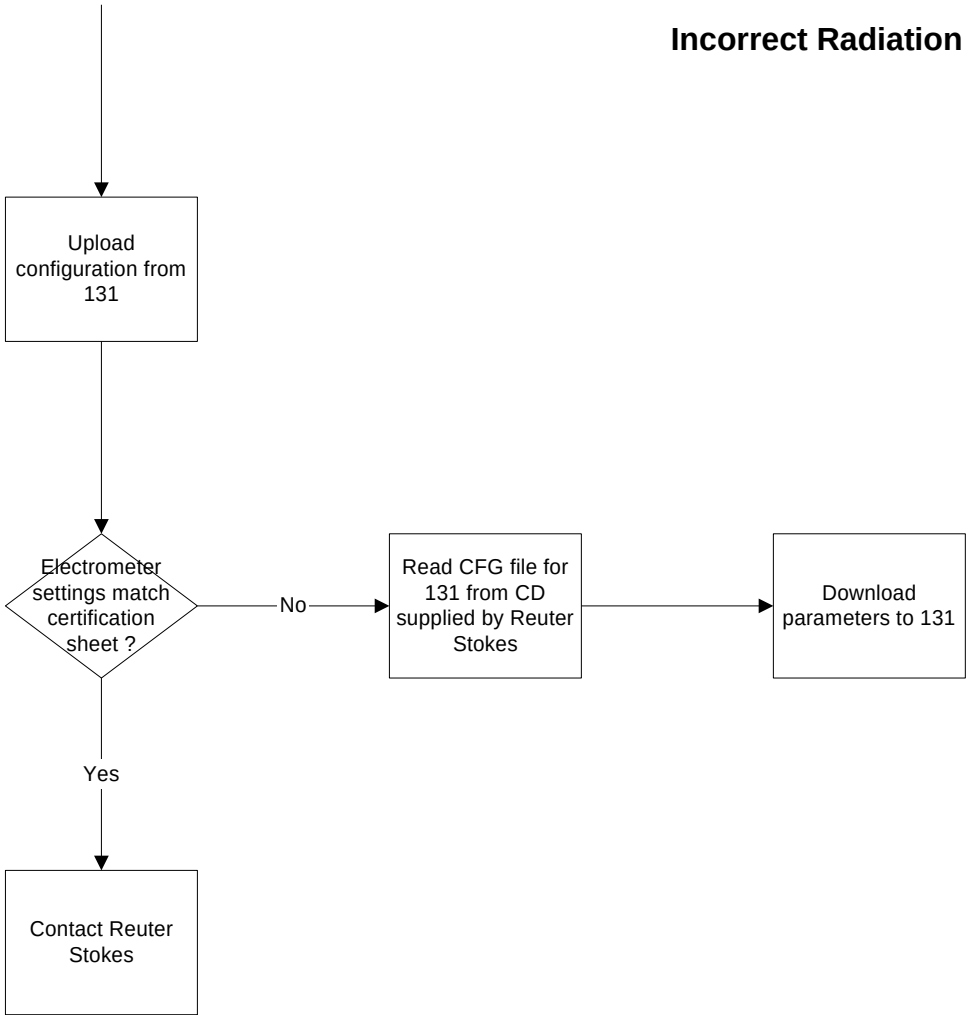
## Incorrect Radiation Readings


Upload configuration from 131
Electrometer settings match certification sheet ?
No
Read CFG file for 131 from CD supplied by Reuter Stokes
Download parameters to 131
Yes
Contact Reuter Stokes



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# Sensor Calibration

## Introduction

Calibration is accomplished by placing the RSS-131 in a well-defined radiation field and adjusting calibration constants to produce a prescribed output. The exact details of a user's calibration procedure depend upon the equipment and resources available as well as the requirements of the user.

## Calibration Check

It is recommended to implement a rapid method of checking the stability of the sensor calibration. The intent of the checking process is to identify substantial changes in instrument calibration. The check consists of establishing a reproducible arrangement of a long half-life isotopic source (e.g. Cs137) and the installed sensor. The increase in the sensor indication above background due to the check source is proportional to the sensitivity of the sensor. Any change in this indication is evidence of a change in calibration.

To perform this check an average value for background should first be computed. This can be done by averaging for about 5 minutes. Note this value and place the check source in a reproducible location in the center of the chamber. Again average the readings for about 2 minutes and note this value. By subtracting the background from the check source value you will obtain the increase due to the source. It is this value that should be constant if the calibration does not change. If carefully performed this method should be reproducible to within about 1%.



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# Sensor Calibration Procedure

## Scope

The following procedure is for calibration of the RSS-131 sensor in the low range and adjusting the RAC parameter of the system if required.

This procedure employs a "shadow shield" method using a Cs137 (or Co60 ) source. It includes instructions for averaging readings made at different field strengths, calculating instrument sensitivity in millivolts per micro roentgen per hour and converting that figure to sensitivity to a Ra226 spectrum. A procedure is included for adjusting the RAC parameter of the system, if required, to bring the instrument into specified tolerance. The number of measurements taken and the distances used are up to the calibration system designers. The sample calculations show measurements taken at 10, 12, 14, 16 and 18 feet.

## Safety

Observe radiation safety practices when working with a radioactive source. Due to the weight of the lead shield insure the stand that holds them is stable.

## Equipment

A. Data collection system to monitor and average the analog output signal

B. Cs137 or Co60 Radiation source and holder.

C. Shield (lead bricks).

D. Work area of about 25' (8m) by 6' (2m). Keep ion chamber at least five feet in front of a wall to reduce reflected radiation effects.

## Procedure

### Set Up Equipment

A. Attach sensor head enclosure to tripod and adjust height to approximately 60" (1.5m) from floor to center of chamber.

B. Hang a plumb line from a point under the chamber housing on chamber centerline to the floor. See Figure 12 to determine chamber center on bottom of housing.

C. From this point on the floor, measure values of "D", 10, 12, 14', 16', and 18' in a direct line.

D. Attach read-out housing to sensor head housing with the cable provided.

E. Attach the data collection system to the analog I/O output of sensor.

F. Set source at the 10-foot mark, the same height above the floor as the chamber centerline. See Figure 13.



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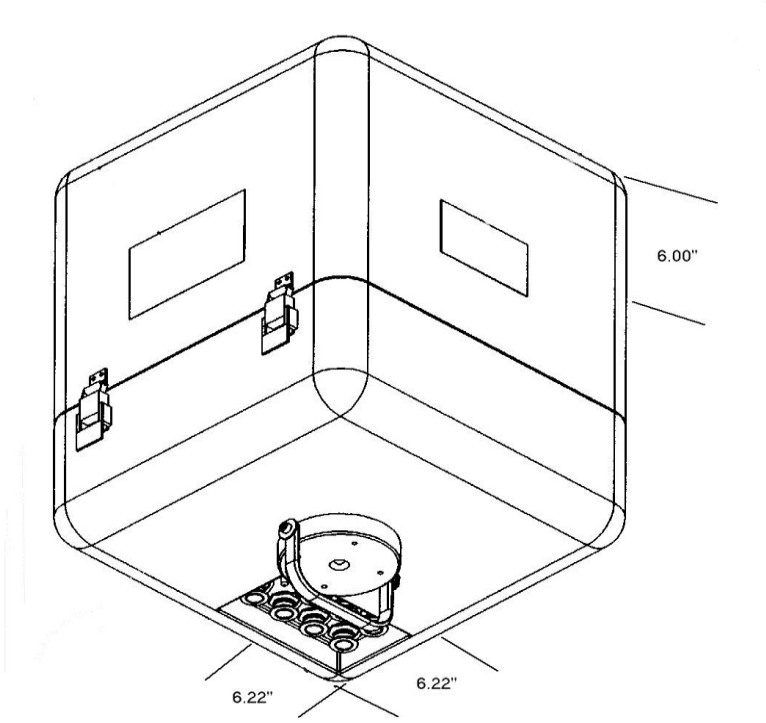


**Figure 12: HPIC Dimensions Relative to Center of Ion Chamber**



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## Take Measurements

A. Connect an analog output cable to the RSS-131 I/O connector. This cable should use only pin 1 (HPIC output signal) and pin 8 (ground). This cable should be connected to a data collection system which will be used to average recorded data over the sampling period.

B. Position the sensor a distance D from the source. This distance will change throughout the test. Recommended distances for this procedure are 10, 12, 14, 16 and 18 feet. If these distances are used the sensor should be positioned 10 feet from the source for the first test.

C. Apply power to the sensor and turn it on.

D. Remove the shield so the source is not obstructed from the sensor (see Figure 13). Allow signal to stabilize (approximately 1 minute), then start recording data to the data collection system.

E. Record for a time period sufficient to obtain a stable reading.

F. Stop recording to the data collection system.

G. Move the shield into place between source and ion chamber. Shield centerline must be on a line from chamber centerline to source. The shield must be placed between the source and sensor so that it completely shields the detector from the source. See Figure 14.

H. Allow reading to stabilize and record to the data collection system for a time period sufficient to obtain a stable reading.

I. Repeat steps D through G with additional desired distances.

**NOTE:** *Always keep the source and the shield, when used, at the same height "h" as the ion chamber centerline and along the same straight line from the ion chamber center.*

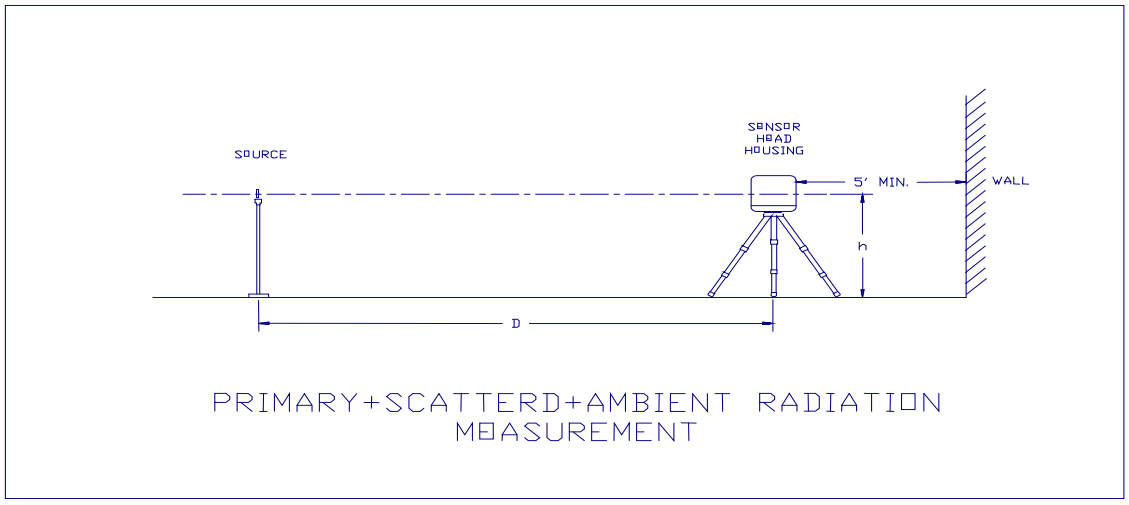


**Figure 13: Calibration Setup With No Shield**



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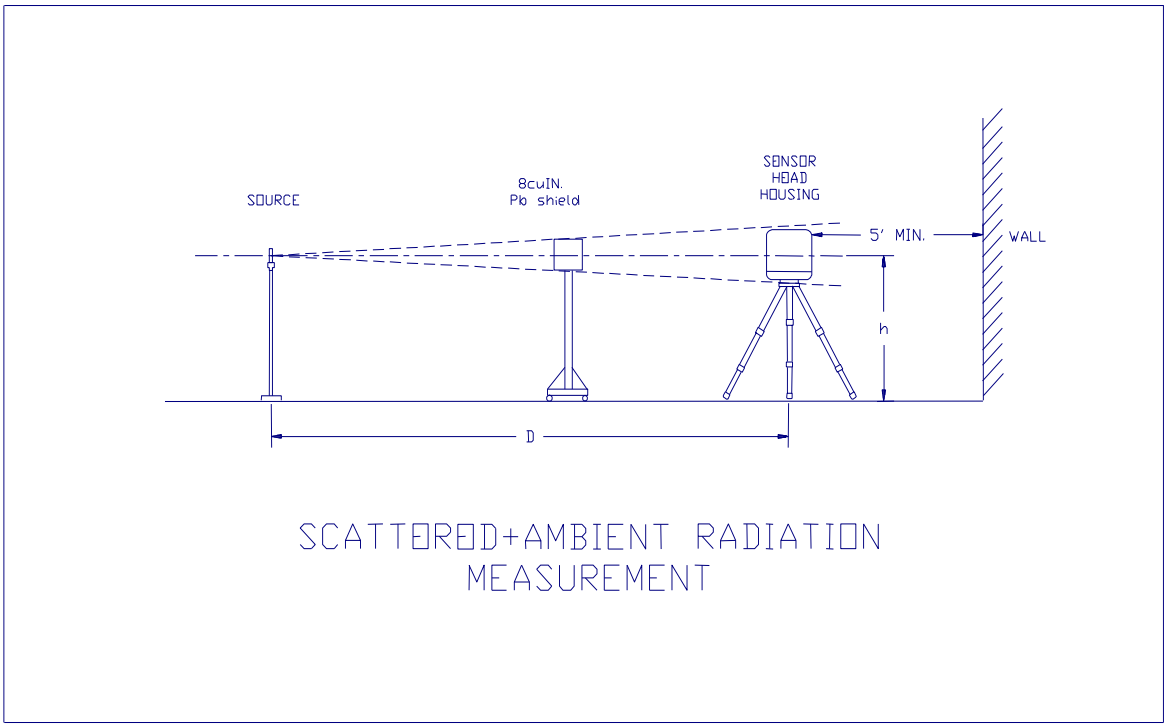


**Figure 14: HPIC Calibration With Shield**



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## Calculating Sensitivity

A. The Sample Calibration Sheet at the end of this appendix is a convenient form for recording data and calculated sensitivity.

B. The column labeled "P+S+A" (Primary + Scattered + Ambient) is the reading in millivolts (mV) made with NO shield between the source and the chamber.

C. The column "S+A" (Scattered + Ambient) is the reading in mV taken with the shield in place.

D. The column labeled "P" (Primary) is the difference of the readings:

mV(P) = mV(P+S+A) - mV(S+A)

E. The exposure rate is determined for each distance involved from the exposure rate at 1 meter from the source.

F. The source calibration indicates the exposure rate at one meter on a specific date. This exposure rate must be corrected for the decay of the source from date of certification to the date of the calibration run as follows:

Kd = e-0.693(t/T)

where $K_d$ = the coefficient of decay.

e = natural logarithm base.

t = time between the date of source certification and calibration.

T = the half-life of the source. (5.26 years for $Co^{60}$)

**NOTE:** *The values of "t" and "T" must both be expressed in the same unit of time, such as days or years.*

G. To calculate Exposure Rate E at the various distances "D" used:

$$E = E_{100} * (\frac{100}{D})^2 * e^{-\mu(D-100)} * Kd$$

Where $E_{100}$ = exposure rate produced by gamma source at a distance of 1 meter as indicated on the source certificate.

μ = the linear attenuation factor for air is:

$6.8 \times 10^{-5} cm^{-1}$

D = distance in cm between the center of the source and center of the ion chamber.

$K_d$ = the decay coefficient evaluated in Paragraph F.

H. k($Co^{60}$ or Cs137) = the value of $mV_{(p)}$ divided by the Exposure Rate for the source-to-ion-chamber distance being used.

I. $\bar{k}$ = the average value of k

J. σ = the standard deviation



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$$\sqrt{\frac{\sum k_i^2 - n\bar{k}^2}{n-1}}$$

*OR*

$$\sqrt{\frac{n\sum k_i^2 - (\sum k_i)^2}{n(n-1)}}$$

where n = number of measurements of k, typically 5.

K. V = σ/k should be less than 1%. If not, the readings show too much variation, and may not be valid - repeat the readings carefully.

L. $\bar{k}$ ($Ra^{226}$) = the average value of k corrected for the radiation energy spectrum of $Ra^{226}$ by the relation:

$\bar{k}$ ($Ra^{226}$) = (0.91) × $\bar{k}$ ($Cs^{137}$)

or (1.022) × $\bar{k}$ ($Co^{60}$)

M. Calculate the radiation constant RAC. The equation to do this is:

RAC = $\bar{k}$ ($Ra^{226}$) / RLN * 1000

where RLN is a constant which varies from unit to unit. This constant is supplied on the original calibration certificate from Reuter Stokes.



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## Sample Calculations

A. Calculate Exposure Rate at distance "D" from Co60 source "t" years after source certification.

$$D = 12 \ \ feet(365.8 \ \ cm)$$

$$t = 3.37years( \ \ 1230.8days \ \ )$$

$$T = 5.26years( \ \ 1920days)$$

$$E_{100} = 1062 \ \ uR/h$$

**Examples:**

$$E_{12} = E_{100} * \left(\frac{100}{D}\right)^2 * e^{\mu(D-100)} * K_d$$

$$E_{12} = 1062uR/h \ \ \left(\frac{100}{365.8}\right)^2 * e^{-6.8E \ -5(265.8)} * e^{-0.693(3.51 \ \ /5.26)}$$

$$E_{12} = 1062uR/h \ \ * 0.07475 \ \ * 0.982 \ \ * 0.63$$

$$E_{12} = 49.1uR/h$$

B. Sensitivity of sensor at distance "D" from $Co^{60}$ source.

**Example:**

| D | | EXPOSURE RATE | P+S+A | S+A | P | k($Co^{60}$) |
|---|---|---|---|---|---|---|
| FEET | cm | µR/h | MV | mV | MV | mV/µR/h |
| 12 | 365.8 | 49.10 | 1275.7 | 296.2 | 979.5 | 19.95 |

$$k = \frac{(P+S+A) - (S+A)}{\text{Exposure Rate}}$$

$$k = \frac{1275.73mv - 396.24 \ mv}{49.10\mu R/h}$$

k = 19.95 mv/µR/h



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C. Calculate the average sensitivity

**Example: In a typical calibration, the following values of k might be calculated.**

| D | | K |
|---|---|---|
| FEET | CM | mV/μR/h |
| 10 | 305 | 20.01 |
| 12 | 366 | 19.96 |
| 14 | 427 | 19.91 |
| 16 | 488 | 19.93 |
| 18 | 549 | 19.92 |
| | Average($\bar{k}$) | 19.95 |

D. Calculate standard deviation σ.

**Example: Using the data of Section C**

$$\sigma = \sqrt{\frac{1}{n}\sum_{1}^{n} k_i^2 - \bar{k}^2} * \sqrt{\frac{n}{n-1}}$$

$$\sigma = \sqrt{\frac{1}{5}(20.01^2 + 19.96^2 + 19.91^2 + 19.93^2 + 19.92^2) - 19.95^2} * \sqrt{\frac{5}{4}}$$

$$\sigma = 0.04$$

E. Calculate coefficient of variation of individual readings.

V = σ = 0.040 = 0.20

$\bar{k}$ 19.95

V = 0.20% which is less than 1% and indicates acceptable data.

F. Correct k($Co^{60}$) to k($Ra^{226}$).

$\bar{k}$ (Ra226) = (1.022) $\bar{k}$ (Co60) = 1.022 x 19.95 mv/μR/h

$\bar{k}$ ($Ra^{226}$) = 20.39 mv/μR/h

G. Calculating RAC parameter.

$$RAC = \frac{\bar{k}(Ra^{226}) * 1000}{RLN}$$

H. RLN was measured during the Temperature Compensation Test, see unit's Calibration Parameter Sheet or check the Electrometer parameters with the RSS131Config utility program.



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**Example:**

$$RAC = \frac{k(Ra^{226}) * 1000}{RLN}$$

$\bar{k}$ ($Ra^{226}$) = 12.31 mv/μR/h

RLN = $5 \times 10^{11}$

$$RAC = \frac{12.31 \text{ mv/ } \mu\text{R/h } * 1000}{5 \text{ x } 10^{11}}$$

RAC = $2.46 \times 10^{-08}$



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## Sample Calibration Data Sheet

# Calibration Data

Sensor Type: 100 mR/Hr Source (Cs-137): BB-440
Serial Number: Date of Certificate: 12/1/94
Calibration Date: 3/27/98 Exposure Rate at 1 meter: 4.226 mR/h
Calibration Interval: 12 months Temperature: $70^0$ F
Customer Name: STOCK Humidity: 50% RH

**AS FOUND CALIBRATION DATA**

| Distance | | Field Strenth | P+S+A | S+A | P | Sensitivity Cs-137 |
|---|---|---|---|---|---|---|
| Feet | cm | uR/h | V | V | V | mV/uR/h |
| 12 | 366 | 287.327 | 7.371 | 1.534 | 5.837 | 20.31 |
| 14 | 427 | 210.224 | 5.587 | 1.339 | 4.248 | 20.21 |
| 16 | 488 | 160.287 | 4.421 | 1.192 | 3.229 | 20.15 |
| 18 | 549 | 126.123 | 3.610 | 1.072 | 2.538 | 20.12 |

Average Cs-137 Sensitivity: 20.22
Standard deviation: .086
Percent Variance: 0.427%
Average Ra-266 Sensitivity as found: 19.98

By:_____

Date:_____

***NIST = National Institute of Standards and Technology formerly NBS**



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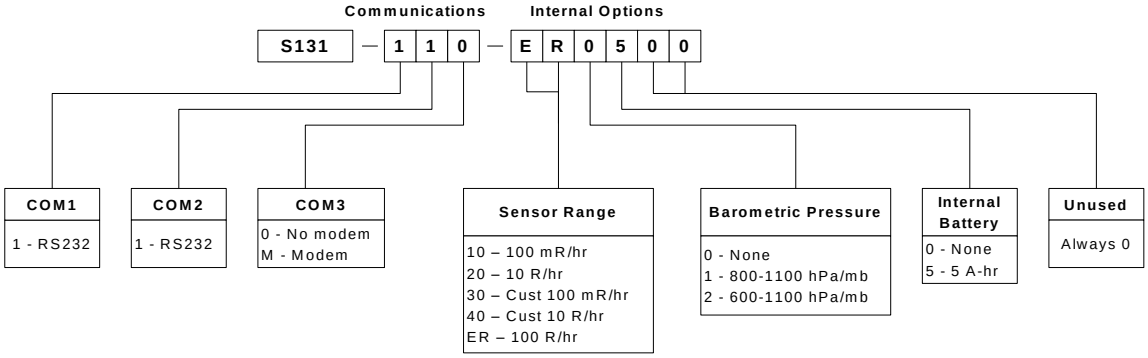
**RSS-131ER Configuration Matrix**




| External Options | | |
|---|---|---|
| **Part Number** | **Description** | **Note** |
| DEV2-87 | Battery Charger, No CE mark | Old style, no cordset, large |
| DEV35-1 | Battery Charger, CE mark | New style, no cordset, small |
| S131-BC-002 | Battery Charger, USA | Old style, no CE, USA cordset |
| S131-BC-003 | Battery Charger, EU/Korea | Old style, no CE, EU/Kor cordset |
| S131-BC-004 | Battery Charger, Hong Kong | Old style, no CE, HK cordset |
| S131-BC-006 | Battery Charger, CE, USA | New style, CE, USA cordset |
| S131-BC-007 | Battery Charger, CE, EU/Korea | New style, CE, EU/Korea cordset |
| S131-BC-009 | Battery Charger, CE,Hong Kong | New style, CE, HK cordset |
| S131-BC-010 | Battery Charger, NJDEP | Old style, no CE, NJDEP only |
| S131-PRGC-001 | Programming Cable | One serves multiple systems |
| S131-232-001 | COM1 RS-232 Cable | Only with ENG approval |
| S131-232-002 | COM2/COM4 RS-232 Cable | One per system |
| S131-SOLR-001 | Solar Power Option 6V | Not with battery |
| S131-AOC-001 | Analog Cable | Backward compatibility w/121 |
| CN7-10 | 4 pin Switchcraft connector | Modem, COM1 customer cable |
| CN7-11 | 6 pin Switchcraft connector | External power customer cable |
| CN7-12 | 7 pin Switchcraft connector | Wind/rain customer cable |
| CN7-13 | 8 pin Switchcraft connector | Analog, COM2/4 cust cable |
| EN3-8 | Tripod | |
| **S131-TB-001** | Tipping Rain Bucket Assy | Includes bucket and cable |
| MET1-6 | Tipping Rain Bucket | |
| S-131-001-26 | Tipping Rain Bucket Cable | 10 feet long |
| **S131-WND-001** | Wind Sensor Kit | Includes wind sensor and cable |
| MET1-9 | Wind Sensor | |
| S131-WDS-001 | Wind Sensor Cable | 10 feet long |
| **S131-KIT-WR** | Wind and rain kit | Includes sensors and cable |
| MET1-9 | Wind Sensor | |
| MET1-6 | Tipping Rain Bucket | |
| S131-TBWS-001 | Rain/Wind cable assembly | 10 feet long |
| **S-131-ESD-001** | Ext Ser RS-232 Disp Kit 20" | Includes display and cable |
| DSP1-1 | Ext Ser Marquee Display 20" | |
| S131-232-003 | Ext Ser Disp Cable DB9 | |
| **S-131-ESD-002** | Ext Ser RS-232 Disp Kit 7.2" | Includes display and cable |
| DSP1-4 | Ext Ser Marquee Display 7.2" | |
| S131-232-004 | Ext Ser Disp Cable Fly Leads | |
| **S-131-ESD-003** | Ext Ser RS-485 Disp Kit 20" | Includes display and cable |
| DSP1-5 | Ext Ser Marquee Display 20" | |
| S131-232-005 | Ext Ser Disp Cable DB9 | |
| DEV27-1 | Black Box 232/485 Converter | |

| Standard Items for Every System | |
|---|---|
| **Part Number** | **Item** |
| **S131-CD*** | **RSS131 Application CD** |
| SFTW-131-001 | RSS131 Firmware |
| SFTW-131-002 | RSS131 Config Utility |
| RSS-131-OM | RSS131 User Manual PDF |
| **S131ER-CD**** | **RSS131ER Application CD** |
| SFTW-131-001ER | RSS131ER Firmware |
| SFTW-131-002 | RSS131 Config Utility |
| RSS-131-OM | RSS131 User Manual PDF |
| **S131-KIT-STD** | **1 per unit** |
| RSS-131-OM | RSS-131 User Manual |
| S131-232-002 | COM2/COM4 RS-232 Cable |
| S131-PRGC-001 | Programming cable |
| CN7-11 | Connector for external power |

* The **S131-CD** contains all software and user manual for the 100 mR/hr and 10 R/hr units.

** The **S131ER-CD** contains all software and user manual for the 100 R/hr ER unit.

| Spare Parts | |
|---|---|
| **Part Number** | **Item** |
| S-131-001-10 | Electrometer (100 mR/hr, 10 R/hr) |
| S-131-001-43 | Extended range electrometer (ER unit) |
| S-131-001-20 | DAQ board without modem |
| S-131-002-20 | DAQ board with modem |



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# External Marquee Displays

## Overview

The RSS-131 supports several external serial displays. These are ordered as optional kits. Each kit contains the display and cable. The exception to this is the RS-485 display kit. Since RS-485 implies the display is placed at a great distance from the RSS-131 it is the customer's responsibility to provide the wiring between the display and the RS-232/RS-485 converter that is provided as part of the kit from Reuter Stokes.

All external displays require configuration through the Configuration Utility. This is detailed below and is common regardless of display type. As always, once the changes are made in the Configuration Utility they must also be downloaded to the RSS-131.

The displays show only radiation values. Other sensors such as barometric pressure, wind speed, etc. are not shown. The RSS-131 must be configured to show data on the display. This will be shown in this section.

All of the display kits require AC power for the display. The serial cables which are part of the display kits can be used on COM1, COM2 or COM4 on the RSS-131.



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# Software Configuration

The RSS-131 does not display radiation to the external display as it is shipped from the factory. It must be configured via the RSS-131 Configuration Utility. The RSS-131 serial port used must be selected from the General Unit Configuration window as shown in Figure 15. The port used must be selected in the External Display Port frame.

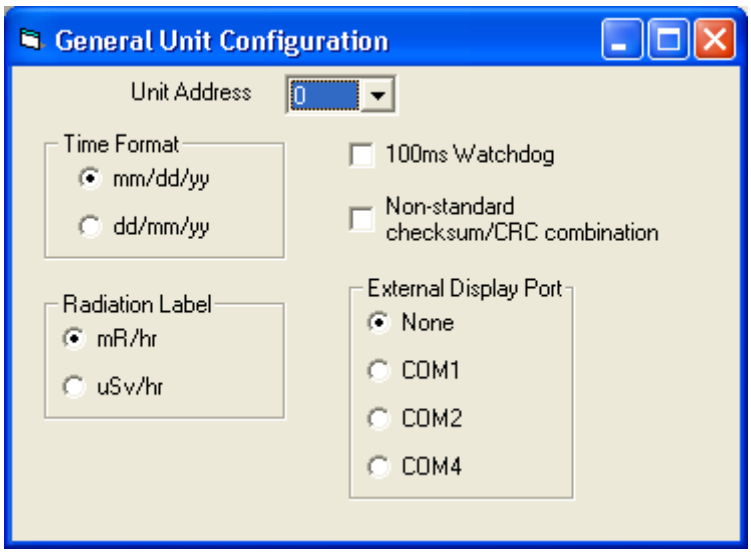


**Figure 15: External Display COM Port Selection**



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The external displays ship from the factory configured for 9600 baud, 8 data bits and 1 stop bit. The RSS-131 COM port used to communicate with the display must be configured for the same parameters (refer to Figure 16). If the user changes settings on the display the RSS-131 port must also be reconfigured.

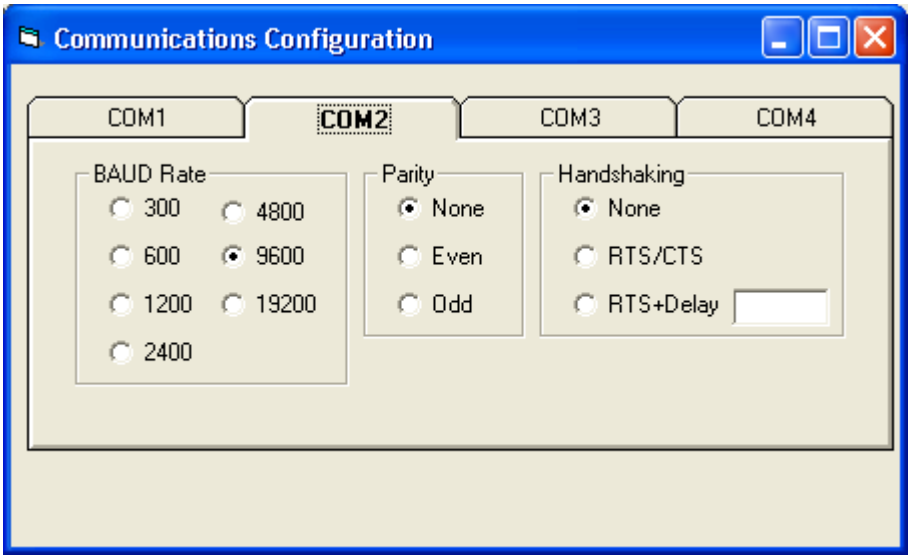


**Figure 16: External Display COM Settings**



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# RS-232 1 x 10 Marquee Display (S-131-ESD-002)

This display kit consists of an RS-232 display and the cable which connects it to the RSS-131. No other components are required and no additional configuration beyond that which was described previously is required.

| Part | Description | Comment |
|---|---|---|
| DSP1-4 | Serial marquee display with RS-232 interface | 1 line by 10 characters. |
| S131-232-004 | RSS-131 serial cable (COM2 or COM4) | This is connected between the RSS-131 and the display. |

**Table 7: S-131-ESD-001 RS-232 1 x 10 Marquee Display Kit Components**

This display has ten switches which must be correctly set for the display to function properly. This requires the user to remove the small metal cover on the back of the display. This will expose a 10 position dip switch. These switches must be configured as shown Table 8.

| Switch | Position |
|---|---|
| 1 | Off |
| 2 | Off |
| 3 | Off |
| 4 | Off |
| 5 | On |
| 6 | On |
| 7 | Off |
| 8 | Off |
| 9 | On |
| 10 | On |

**Table 8: External Serial Display Switches**

Once the switches are set connect the serial cable (S131-232-003) between the PC and display. The RSS-131 must now be configured to write to the display. For details on configuring the unit refer to the example later in this document. Once set up the system should look as shown in Figure 17.



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S-131-ESD-002

RSS-131 External RS- 232 Display Kit 7.2"Connections

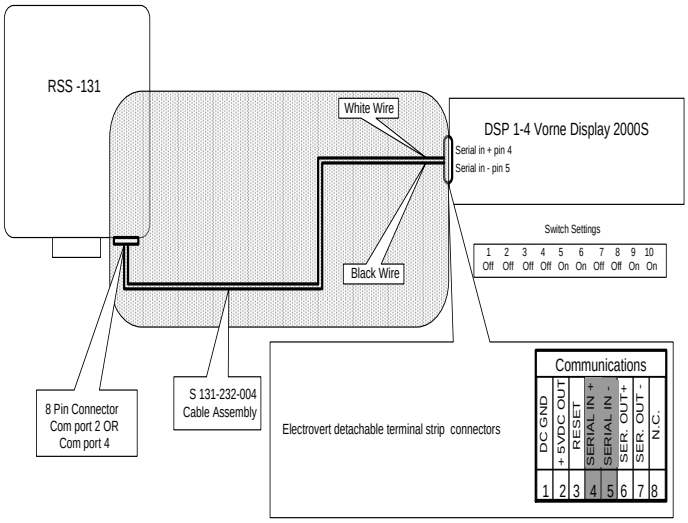


**Figure 17: S-131-ESD-001 RS-232 1 x 10 20" Display System**



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# RS-485 Marquee Display (S-131-ESD-003)

This external display contains its own RS-485 interface. However, the RSS-131 contains only RS-232 interfaces. This means an RS-232 to RS-485 converter is required. This converter is provided as part of the kit from GE. Specifics of the kit are shown in Table 9.

| Part | Description | Comment |
|---|---|---|
| DSP1-3 | Serial marquee display with RS-485 interface | 1 line by 10 characters. |
| S131-232-005 | RSS-131 serial cable (COM4) | This is connected between the RSS-131 and the RS-232/RS-485 converter. |
| DEV27-1 | RS-232/RS-485 converter | This is connected to the serial cable (S131-232-005) on one side. The other side must be connected to customer-supplied RS-485 wiring. |

**Table 9: S-131-ESD-003 Serial RS-485 Display Kit Components**

The system should be set up as shown in Figure 18. The S131-232-005 cable must be connected to COM4. All components except the 2 wire connection between the RS-232/RS-485 converter and external display are provided as part of the kit. The display contains two DB9 serial connectors. The customer-provided wiring should connect to the male connector.



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# RSS-131 to RS-485 Display Hook-up

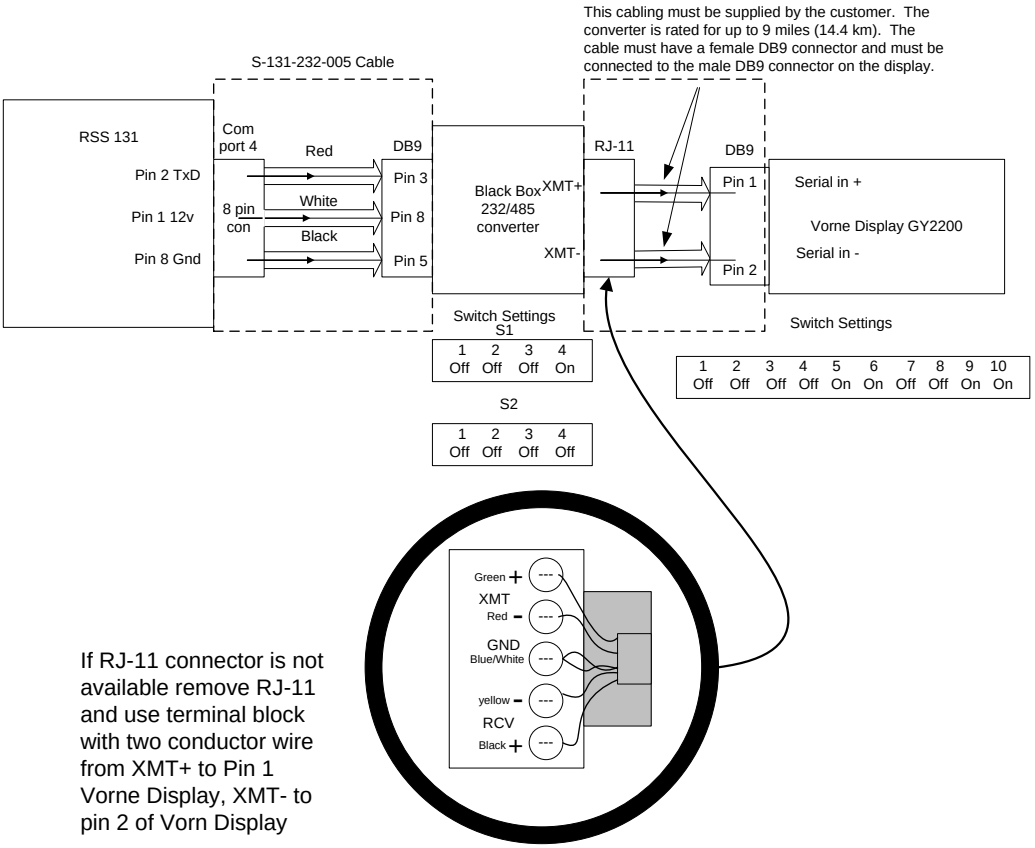


**Figure 18: S-131-ESD-003 RS-485 Serial Display System**



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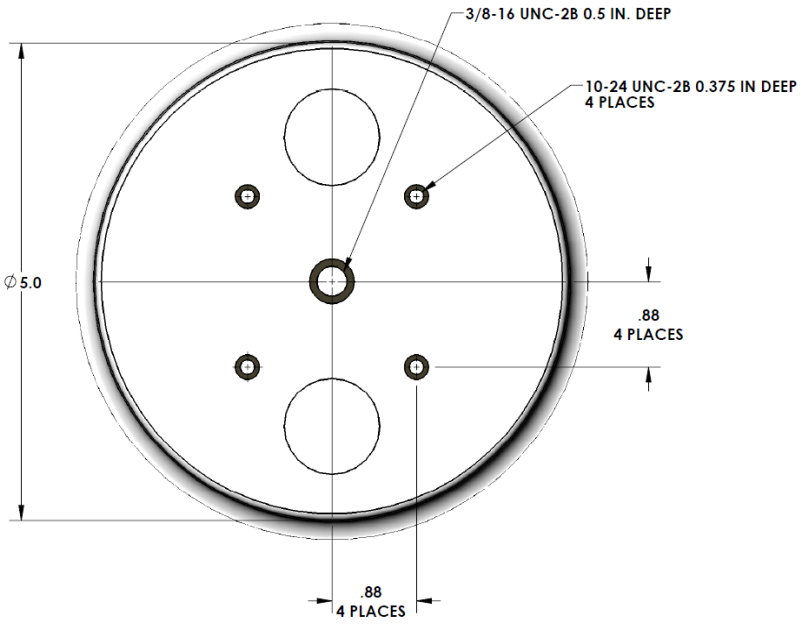
# Mounting and Installation Requirements

While the RSS-131 is a portable device, it may also be permanently mounted in any orientation with suitably designed brackets and is not sensitive to detector orientation. Generally, the RSS-131 will be mounted with the cable connectors facing down. The integral mounting flange on the "top" surface of the enclosure is compatible with tripod-type mounting systems, and will accept #10"-24 machine threaded screws or bolts.

Grounding of the RSS-131 is accomplished at a grounding point on the mounting flange by means of a screw and lockwasher. This screw is identified by a grounding symbol sticker with the symbol . In normal operation, grounding of the unit is not required. Consult local electrical codes or normative references.

The recommended installation steps are as follows:

1. Ensure the RSS-131 is powered off.
2. Mount the RSS-131 on the support structure using customer-provided hardware.
3. Connect desired communication cables.
4. Connect external power cable. The RSS-131 power wiring is shown the External Connectors section.
5. Apply power to the unit.
6. Monitor data until the unit is operating properly. This can be done using the Configuration Utility.




Mounting Flange Dimensions (inches)



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